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ASC-R-118

NAVY AIR-LAUNCHED MISSILE OPERATING AND SUPPORT COST ESTIMATING MODEL

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JUN 7 1979

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CONTRACT NO. N00014-77-C-0180

April 1979

172 p.

Prepared for

Office of the Chief of Naval Operations
Advisor for Resource Analysis (OP-96D)
The Pentagon
Washington, D.C. 20350

by

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FALLS CHURCH, VIRGINIA

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ABSTRACT

On August 31, 1977, the Cost Analysis Improvement Group (CAIG), which is responsible for policy and guidance for cost analysis in the Department of Defense (DOD), issued a memorandum which contained an operating and support (O&S) cost element structure (CES) for tactical air-launched missiles, to be used in all Defense System Acquisition Review Council (DSARC) reviews and other missile cost analyses. Accordingly, the Resource Analysis Group (Op-96D), which is responsible for independent cost analysis within the Navy, tasked Administrative Sciences Corporation to undertake a study and accomplish the following objectives:

1. develop and coordinate a Navy air-launched missile operating and support cost element structure,

2. discover data sources and gather available data,

3. develop cost-estimating relationships, and

4. document the effort in a report that can be used as a handbook or guide for Navy air-launched missile O&S cost analyses.

The CES which was developed contains sixteen cost elements which define and encompass the same activities described in the CAIG memorandum. Each cost element is discussed in detail in the body of this report, including the following information:

1. a definition;

2. a discussion of the activitiy, points of contact, historical data, and sources for planning data;

3. a cost-estimating relationship (CER) including computational procedures; and,

4. an example calculation.

All pertinent data which was collected during the study is included in this report, as well as examples of Navy documents which can be used for cost estimating in the future. Each source is identified by a point of contact and a DOD telephone number. All explanatory variables which were employed in the study, whether used in a CER or not, are also included. These data should be helpful for future CER development.

I. EXECUTIVE SUMMARY

This report presents the work done by Administrative Sciences

Corporation for the Resource Analysis Staff (Op-96D) under contract N00014-

77-C-0180, in the area of Navy air-launched tactical missile operating and

support (O&S) costs. The objectives of the effort were to:

1) develop a Navy air-launched missile operating and support
   cost element structure (CES),

2) discover data sources and gather available data,

3) develop cost-estimating relationships and,

4) document the effort in a report that can be used as a
   handbook or guide for Navy air-launched missile O&S
   cost analyses.

The CES which is shown in Exhibit I-1 captures exactly those costs

defined by the Cost Analysis Improvement Group (CAIG). It was coordinated

with the Air Force and is identical at the major topic level with the Air

Force tactical air-launched missile CES. Each element is discussed in detail

in the body of the report including the identification and discussion of data

sources. The raw data is contained in Appendix C. Cost estimating relation-

ships were developed for every cost element for which the data were amenable.

For other cost elements, cost factors and/or examples of recent cost history

are provided. The factors from the Navy Resource Model (NARM) Program Factors

Manual are included to provide an estimating methodology for the elements which

are of an indirect nature; e.g., Base Operating Support, Personnel Support.

Cost elements which usually comprise the bulk of O&S costs and the

associated "cost drivers" are accorded special emphasis in the discussion, the

data and the CER's. In the case of depot maintenance, two different CER's are

EXHIBIT I-1

NAVY OPERATING AND SUPPORT COST ELEMENT
STRUCTURE FOR AIR-LAUNCHED MISSILES

	Appro-priation	Budget Category[1]	Claimant[2]	Accounting Visibility[3]
o Operations				
1. Handling and Inspection	MPN		CINC	A
2. Operational Training	MPN, O&MN		CINC, NAVAIR NAVSEA	A, D/A
o Below-Depot Maintenance				
3. Organizational/AIMD Maint.	MPN, O&MN		OP-01, NAVAIR	A
4. Intermediate Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o Installations Support				
5. Base Operating Support	MPN, O&MN		CINC, NAVAIR NAVSEA	I
o Depot Maintenance				
6. Depot Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o Depot Supply and Technical Support				
7. Supply Depot Ops	O&MN	7/E/1,2,3	NAVSUP	A/I
8. Technical Support				
Fleet Support	O&MN	7/A/2	NAVAIR 4104	D
Engineering Support	O&MN	7/A/2	NAVAIR 4104	D
Quality Evaluation	O&MN	7/A/4	NAVAIR 4104	D
Program Management	MPN, O&MN		NAVAIR	D/A
o Second Destination Transportation				
9. Transportation	O&MN	7/E/3	NAVSUP	A
10. Receipt, Segregation, Storage & Issue	O&MN, MPN	7/B/1	NAVSEA 04J	A
o Personnel Support Training				
11. Replacement Training	MPN, O&MN	8/A/2,2/E	CNET	A/I
12. Health Care	MPN, O&MN		BUMED	I
13. Personnel Support	MPN, O&MN		OP-01	I
o Sustaining Investments				
14. Replenishment Spares	WPN	2	NAVAIR 412	D/A
15. Modifications	WPN, O&MN	2, 7/A/2	NAVAIR 412	D
16. Replenishment Ground Support Equipment	WPN		NAVAIR 4104	A

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[1] 7/A/2 refers to Budget Program 7, Budget Activity A, Budget Project 2

[2] Claimants: CINC - the Commander-in-chiefs of the Naval Fleets
NAVAIR - Naval Air Systems Command
NAVSEA - Naval Sea Systems Command
CNET - Chief of Naval Education and Training
NAVSUP - Naval Supply Systems Command
BUMED - Bureau of Medicine and Surgery
OP-01 - DCNO Manpower Personnel and Training

[3] D = Direct Cost with individual weapon system visibility
A = Direct Cost without individual weapon system visibility; must be allocated
I = Indirect

provided from which the user may pick the appropriate one. Program data are also provided, and an example calculation is made for every element. The reader, however, is cautioned in Section II regarding the necessity of confirming all program and operational data with knowledgeable fleet personnel.

The report is written in handbook form so that it can be used both as an educational tool for a new analyst and an estimating model for the experienced analyst. Appendix E is designed to serve as a user's guide for both experience levels. The new analyst can refer to Table E-1 which lists all the variables required by the equations in this report. These variables are organized by source in Table E-2; i.e., all the data which should be obtained from the program office, or from the assistant project manager for logistics (APML), or from the OpNAV sponsor (Op-506), etc., are grouped together. The new analyst therefore can satisfy all data requirements from a particular source with a single request.

For the experienced analyst, Table E-3 provides a listing of the cost elements, a brief definition for each, the computation procedure including cost-estimating relationships, and a reference which identifies the major data source and tells where additional background information can be found. Once the analyst digests the information in this report and obtains a working knowledge of missile O&S, he need refer only to the summary of the CER's contained in this table. Finally, Table E-4 contains the cost element structure with the appropriation, claimant and point of contact for each. This provides the reader with an easy guide for gathering data in the future.

II. INTRODUCTION

Since the decision to buy a new weapon system commits the Navy
to operate and support it over its operating life, it is important that
the operating and support (O&S) costs, as well as research and development
(R&D) and procurement costs, be understood and analyzed during the acquisi-
tion process. This has become increasingly important in the last decade as
O&S costs have exceeded the sum of R&D and procurement costs for many systems.
The basic tasks involved in managing and controlling O&S costs are as follows:

1) estimate O&S costs during the acquisition process;

2) observe and record O&S costs throughout the life of
   the system in the fleet;

3) learn what operating and maintenance policies and
   procedures drive O&S costs; and

4) feed back information to the industrial community so
   that the designsof future systems incorporate O&S
   cost savings.

The Cost Analysis Improvement Group (CAIG) has taken the lead in
stressing the importance of O&S cost analyses especially relating to Task 1.
On August 31, 1977, the CAIG issued a memorandum which contained a cost element
structure (CES) for tactical air-launched missiles, including definitions. The
memorandum, the missile CES, and definitions,all of which are included in this
report as Appendix A, are important because they establish the ground rules for
performing missile O&S analyses for all services -- what to include, what not to
include.

Appendix B contains the Navy tactical air-launched missile CES developed during this effort, complete with definitions and the funding appropriation and claimant. The CES was prepared to capture exactly those costs defined in the CAIG memo, and at the same time, reflect the uniqueness of the Navy organization, mission, and support concepts. It was also coordinated with Air Force cost analysts and is identical to the CES developed by the Air Force at the major heading level (Operations, Below-Depot Maintenance, Depot Maintenance, etc.) The material is organized as a single section to permit it, when excerpted from this report, to serve as initial guidance for a Navy Program Manager or Study Director in preparing an O&S analysis for a Navy tactical air-launched missile.

Section III of the report contains information for each cost element consisting of a definition of the element, a discussion of the data sources, the computational procedure including a CER, and an example calculation. Since the CES contains several cost elements (Base Operating Support, Personnel Support, Health Care, etc.) which are general in nature and for which no weapon-specific data is collected, the methodology from the Navy Resource Model (NARM) Program Factors Manual is utilized to generate cost estimates. Simply speaking, the methodology consists of the identification of certain support resources (dollars and personnel) from the budget and allocation of these resources back to weapon systems on the basis of some proxy variable or variables (usually the number of direct personnel) which are chosen to approximate the weapon systems' demand for support. This methodology, although indirect, has many advantages. It provides a consistent, logical procedure for estimating costs which would

otherwise be extremely difficult to estimate; it is well recognized and accepted; and, it provides consistency with the other analyses supported by the NARM. A complete discussion of the methodology can be found in Section III in each section where the methodology is utilized.

Section IV of this report provides a listing of the data base which supported the regression analysis used to develop the CER's contained in this report, and a brief discussion of some of the data problems. This is included to facilitate future CER development.

Appendix C contains the raw data and program information collected during this study which were used to develop the CER data base described in Section IV. Appendix D contains a metric conversion chart. Since current DOD contracts require the use of metric measures in all reports, this chart is included to facilitate comparison/conversion of this data, which is entirely metric, to other previously developed data. Appendix E is a user's guide and provides simple instructions on the preparation of a missile O&S analysis using this report. Table E-2 groups all the variables defined in the report according to the most likely sources. This provides the uninitiated analyst with directions about where to go and what information to seek. Tables E-3 and E-4 contain a summary of the CER's and points of contact respectively.

Finally, it should be emphasized in the strongest possible terms that the "rules of thumb" and other descriptive type information contained in this report are for the purpose of providing background information and facilitating the education of the reader. They are valid only for the time period during which this report was prepared and, IN NO WAY DOES THE PRESENCE OF THIS INFOR-MATION ALLEVIATE THE ANALYST OF THE RESPONSIBILITY OF RECONFIRMING ALL OF THE INFORMATION WITH THE FLEETS AND THE SUPPORTING COMMANDS DURING EACH SUBSEQUENT ANALYSIS.

III.   COST ELEMENT DISCUSSION AND ESTIMATION

The purpose of this section is to provide a definition, a discussion of the supporting data, and a methodology for developing a cost estimate for each of the cost elements listed in Table III-1. In many cases the methodology will take the form of a statistical cost-estimating relationship (CER). In such cases the equation will be given with t-statistics followed by the adjusted coefficient of determination, the standard error of the estimate, the determinant of X'X, the F Statistic, definitions of all variables and the data base. In instances where a CER is not provided, enough information will be provided to support a rudimentary cost estimate; and, an example calculation will be made. This calculation is intended to be a benchmark based on general knowledge which will provide the analyst an example of a reasonable value for each variable and for the total cost. The example calculation should not supplant detailed analysis, but rather it should serve as an indication of the order of magnitude of the cost one could expect for a particular cost element.

Escalation was based on the August 1977 memorandum from the Office of the Secretary of Defense (OSD). The O&MN escalation rates are given below:

	75	76	TQ	77	78	79	80
O&MN	0.755	0.817	0.868	0.878	0.940	1.000	1.080

The missiles discussed in this report and used to develop the CER's are those currently in the Navy inventory or under development. Their names and official designations are as follows:

NAVY MISSILES

Name	Designation
Sidewinder	AIM-9
Sparrow	AIM-7
Walleye I	GW-MK1
Walleye II	GW-MK5
Shrike	AGM-45
Standard Arm	AGM-78
Phoenix	AIM-54
Harpoon	AGM/RGM/UGM-84
Harm	AGM-88

EXHIBIT III-1

NAVY OPERATING AND SUPPORT COST ELEMENT
STRUCTURE FOR AIR-LAUNCHED MISSILES

	Appro-priation	Budget Category[1]	Claimant[2]	Accounting Visibility[3]
o Operations				
1. Handling and Inspection	MPN		CINC	A
2. Operational Training	MPN, O&MN		CINC, NAVAIR NAVSEA	A, D/A
o Below-Depot Maintenance				
3. Organizational/AIMD Maint.	MPN, O&MN		OP-01, NAVAIR	A
4. Intermediate Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o Installations Support				
5. Base Operating Support	MPN, O&MN		CINC, NAVAIR NAVSEA	I
o Depot Maintenance				
6. Depot Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o Depot Supply and Technical Support				
7. Supply Depot Ops	O&MN	7/E/1,2,3	NAVSUP	A/I
8. Technical Support				
Fleet Support	O&MN	7/A/2	NAVAIR 4104	D
Engineering Support	O&MN	7/A/2	NAVAIR 4104	D
Quality Evaluation	O&MN	7/A/4	NAVAIR 4104	D
Program Management	MPN, O&MN		NAVAIR	D/A
o Second Destination Transportation				
9. Transportation	O&MN	7/E/3	NAVSUP	A
10. Receipt, Segregation, Storage & Issue	O&MN, MPN	7/B/1	NAVSEA 04J	A
o Personnel Support Training				
11. Replacement Training	MPN,O&MN	8/A/2,2/E	CNET	A/I
12. Health Care	MPN,O&MN		BUMED	I
13. Personnel Support	MPN,O&MN		OP-01	I
o Sustaining Investments				
14. Replenishment Spares	WPN	2	NAVAIR 412	D/A
15. Modifications	WPN,O&MN	2,7/A/2	NAVAIR 412	D
16. Replenishment Ground Support Equipment	WPN		NAVAIR 4104	A

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[1]7/A/2 refers to Budget Program 7, Budget Activity A, Budget Project 2

[2]Claimants: CINC - the Commander-in-chiefs of the Naval Fleets
NAVAIR - Naval Air Systems Command
NAVSEA - Naval Sea Systems Command
CNET - Chief of Naval Education and Training
NAVSUP - Naval Supply Systems Command
BUMED - Bureau of Medicine and Surgery
OP-01 - DCNO Manpower Personnel and Training

[3]D = Direct Cost with individual weapon system visibility
A = Direct Cost without individual weapon system visibility; must be allocated
I = Indirect

1. HANDLING AND INSPECTION

1a. <u>Definition</u> - This is the cost of personnel and consumable material needed to handle and operate the missile and missile system equipment at the organizational level. Examples of handling and inspection tasks are: removing the missile from organizational storage; missile inspection; missile assembly (usually limited to the attachment of wings and fins); transporting missiles to the aircraft; missile uploading; and missile check-out and arming prior to a captive flight or firing. This cost also includes a similar series of tasks to download the missile and return it to storage if it is not fired. It is improtant to note that there is some variation in missile handling procedures; e.g., some missiles require minor assembly, others do not; some missiles undergo the missile-on-aircraft-test (MOAT) before takeoff, others after takeoff.

1b. <u>Discussion</u> - Some missile systems have a contingent of organizational personnel who are dedicated to the operation and maintenance of the missile system and therefore easy to identify and cost. Other systems have no dedicated personnel and the analyst must compute an equivalent manpower figure by summing the total annual organizational level manhours required for support of the missile system. There are several ways to obtain an estimate of the required handling and inspection manpower. One is to discuss organizational missile operations with Naval personnel who have had experience in that area. Another method is to refer to the Maintenance Engineering Analysis (MEA). A MEA is usually prepared for each missile system and is available through the respective program

offices (see section 8.4, page 57 for a list of the program offices).
Contained in the MEA is the following information:

1) maintenance requirements for each assembled missile and each subassembly;

2) required maintenance tasks;

3) a recommended maintenance level for each maintenance requirement;

4) required support equipment for each task; and

5) task times and personnel requirements by number and type.

As an example, a sample of the worksheets taken from the AIM-7F MEA, which pertain to organizational handling and inspection, are shown as Table C-1 of Appendix C. The work sheets describe each task, the number of men required, their rating and skill level, the time required, and the required support equipment. Based on those engineering estimates found in the MEA, one can compute the average manpower required for one upload/download cycle for an AIM-7F to be two and one-half (2.5) manhours. As a general rule, lighter missiles would probably require less labor, while heavier ones would require more.

In addition to the unit labor requirement, one must also know the number of captive flights in order to compute the total labor required for handling and inspection tasks. Planning data on the captive carry rates for missiles can usually be obtained from the program offices. For the purpose of providing background information, the HARM program office was using the rate of one captive carry, with two missiles per deployed aircraft per month. Captive carry rates for air-to-air missiles such as Sidewinder (AIM-9), Sparrow (AIM-7) and Phoenix (AIM-54) are usually higher. Again, for the purpose of providing background information, one can assume that on the average five or six

carriers are active at all times, each with two attack squadrons (twelve air-craft each) and two figher squadrons (twelve aircraft each). This computes to an average of 120 to 144 attack and 120 to 144 fighter aircraft deployed at any one time. The analyst is cautioned that although this information is represen-tative, actual experience may vary, sometimes greatly. It is incumbent upon the analyst to check with the program office of the particular missile under review and/or with a representative of the fleet to determine what the current or planned captive carry rates are.

Actual data on captive flight activity of missiles already in the inventory is contained in the maintenance data collection system (MDCS) for air-launched missiles, which is maintained at the Fleet Analysis Center (FLTAC) in Corona, California. This information, however, is not part of FLTAC's Perfor-mance Monitoring System (PMS), a conversational system which provides users with ready access to the most frequently requested data, and therefore would require a special run. The charge for this run is estimated by FLTAC to be two to four thousand dollars. Captive flight infomation for Phoenix and Sparrow, however, is currently available in a series of reports known as deployment reports. A deployment report is prepared after each deployment for the assistant project manager for logistics (APML) in NAVAIR 4104 and the Pacific Missile Test Center (PMTC). These reports contain the following information for each missile uploaded on the carrier:

- the number of captive flights, if any;

- the bureau number of the carrying aircraft;

- the duration of each captive flight;

- the ordnance station on the aircraft on which the missile was carried;

- the number of failures; and,

- many other items of information.

FLTAC has a request pending to prepare these deployment reports, which cost
approximately ten thousand dollars annually per weapon, for all air-launched
missiles. This information is useful in estimating future captive carry rates
of missiles under development in two ways:

1. It gives historical data on missile systems which may be
   forerunners to other systems under development (e.g. AIM-
   7E, AIM-7F).

2. It serves to give the analyst an idea of the accuracy of
   planning estimates vis-a-vis actual data from the fleet.

Although the definition for Handling and Inspection includes the
cost of consumable material, this cost is negligible or non-existent for current
Navy air-launched missiles.

1c. <u>Cost-Estimating Relationship</u> - The analytical representation of the com-
putation of Handling and Inspection costs is given below:

$$HI = DE \times EPR + DO \times OPR + CM$$

$$DE = \frac{LU}{1440} \times NM \times CF$$

where,

HI = the annual cost of handling and inspection of air-launched
tactical missiles. (FY79$K)

DE = the number of equivalent direct enlisted manyears required
for handling and inspection tasks.

EPR = the annual enlisted pay rate.* (FY79$K = 9.517)

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*Pay is defined here and throughout this report as the average annual pay rate
by categories (officer, enlisted, cadet and trainee) found in the Five Year
Defense Program (FYDP) for military pay and allowances. The rates are obtained
by dividing total military pay and allowances for each category by the average
annual military strength in each category, and are readily available through
the <u>Navy Resource Model (NARM) Program Factors Manual</u> prepared by Op-901 (X-55038).
FY79 rates are $22,141 for officers and $9,517 for enlisted.

DO = the number of direct officer manyears (if any) required for handling and inspection tasks.

OPR = the annual officer pay rate. (FY79$K = 22.141)

CM = the annual cost of consumable material required for handling and inspection tasks.[1]

LU = the number of manhours required to successfully upload and download a missile.

NM = the number of missiles carried per captive flight.

CF = the annual number of captive flights.

The variable LU which is given in manhours is divided by 1440 productive manhours per manyear to transform it into manyears. This factor is commonly used in manpower planning to determine personnel requirements. If it is felt that a different factor is more appropriate for a particular circumstance, it may be substituted in lieu of 1440. Also note, that the variables DE and DO (in addition to similar variables in Cost Element 3 - Organizational/AIMD Maintenance) are measures of the equivalent direct manpower necessary to operate and maintain the weapon system and are used as proxy variables to compute other costs. This will be discussed in detail later in this chapter and is mentioned here only to place proper emphasis on the variables DE and DO.

1d. Example Calculation

Assume:

LU = 2.5 manhours

NM = 2.0 missiles per aircraft

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[1]The cost of consumable material for air-launched missiles currently in the fleet is negligible.

CF = (5 carriers with weapons x 24 aircraft/carrier x 1 captive flight/aircraft/month + 2 Naval Air Stations x 10 captive flights/month) x 12 mos./yr. = 1680 annual captive flights

CM = 0

EPR = 9.5 (FY79$K)

DO = 0

$$DE = \frac{2.5}{1,440} \times 2 \times 1,680 = 5.8$$

$$HI = 5.8 \times 9.5 + 0 \times 22.1 + 0 = \$55.1 \text{ (FY79\$K)}$$

2. OPERATIONAL TRAINING

2a. __Definition__ - This is the cost of operational training to attain missile system proficiency and consists primarily of two types of training - pilot training on the Advanced Combat Maneuvering Range (ACMR) and operational firings of live missiles. The former is an instrumented air space where pilots fly through attacks, dogfights, etc., and are able to replay the entire scenario in a classroom environment and discuss their performance and weapons proficiency. The latter type of training, operational firings, consists of the costs involved in expending a live round. These costs generally fall into three areas, range costs, threat simulation, and post flight analysis support. Range costs are the costs associated with opening, clearing, operating and closing the range for a firing exercise, equipping the range with any special telemetry, radar or photography equipment, and any other general software support required by the exercise. Threat simulation costs are the costs associated with presenting a target complete with augmentation or whatever other support is required to create a realistic threat environment. Finally, the post flight analysis support is the engineering effort required to ascertain the performance of the missile and pilot.

2b. __Discussion__ - Costs for use of the ACMR are currently averaging approximately eight hundred dollars ($800) per hour, with an average exercise consisting of two 45 minute sessions. Costs are variable since up to four aircraft may train at any one time. Also, there are plans for several more of these facilities in the future which may drive down the cost per hour. For more information on the ACMR contact Mr. R. Crangle, NAVAIR-06E (X-27785).

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To estimate the cost of range services, threat simulation, and post flight analysis is difficult because the charges for these services vary so significantly that one must actually prepare the specifications for the operational test firing before costs can be estimated with any accuracy. For instance, the charge for range costs at the twenty-six fleet training ranges may vary from over two thousand dollars per hour to nothing. In the case of the Atlantic Fleet Weapons Training Facility (AFWTF) where no charge is made, it is obvious that costs are incurred despite the fact the user is not charged, but to pick out these costs from the operating budgets of the fleet would not be a cost effective effort at this time. Target costs and post flight analysis costs also vary drastically depending on the requirements of the particular shot.

Despite this variability, a list of representative costs shown in Exhibit III-2 has been obtained from various sources and may be used to generate baseline estimates of operational firing costs if specific information is not available. Further information on these costs can be obtained from Mr. H. Kollshegg, NAVAIR-06 (X-27675) and/or Mr. F. Belen, NAVSEA-06N (X-27748).

The number of missiles fired annually depends on a number of factors such as inventory levels, training requirements, tactics evaluation requirements, funding and others. By far the most important of these factors is the inventory consideration. Information on the planned operational firing rates can be obtained from the OPNAV program sponsors (Op-506). The specific individuals are identified below:

Title	Code	Name	Telephone
Air Weapon Systems	Op-506F/506F2	CAPT R.J. Johnson	X-51985
Air-Surface Guided Weapons Coordinator	Op-506F1	LtCMDR J.W. Prueher	X-51985
Air-Air Guided Weapons Coordinator	Op-506F3	CMDR R.C. Allen	X-51985

EXHIBIT III-2

REPRESENTATIVE OPERATIONAL FIRING COSTS

1. Range Costs

This cost varies from range to range. A charge of $1,000 per hour is representative but it should be remembered that a series of firing exercises will usually be conducted when an operational unit comes to a range. The range costs therefore must be allocated.

2. Threat Simulation

Land Targets	Approximate Procurement Cost (FY79$K)	Reuse
Bunker	0	Infinite
Moving Vehicle	10	1-5 Times[1]
Sea Targets		
Moored Hulk	0	5-10 Times
Moving Vessel (Septar)	100	2-5 Times
Air Target (Subsonic)		
MQM-74C	80	2-5 Times[2]
BQM-34 A/S	250	2-5 Times[2]
TOW	8	2-5 Times
Air Target (Supersonic)		
AQM-37A	40	No
BQM-34 E/T	450	2-5 Times[2]
CQM-10B	75	No

Target augmentation costs may range from 0-$35K depending on what is required. For example, HARM would require a radiating target, Harpoon would require augmentation of a Septar to simulate the larger profile of a surface combatant.

3. Post flight analysis also varies with the amount of equipment used and data collected. Currently, a representative effort is 2-3 manweeks, costing $60-70K per manyear depending on which Naval engineering activity performs the work.

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[1]Costs are for special purpose, light target vehicles. If a fully armored, droned tank is required, costs may run to $200K or higher for target vehicle.

[2]Add $3-4K for consumable material and preparation for each reuse. All reuse estimates are approximations. Actual experience may vary, sometimes greatly.

2c. <u>Cost-Estimating Relationship</u> - A general representation of the cost calculation is as follows:

$$OT = 0.80 \times ACMRT + NLF \times UCLF$$

where,

OT = the annual cost of operational training. (FY79$K)

ACMRT = the total annual time spent training on the Advanced Combat Maneuvering Range. (hours)

NLF = the annual number of live firings.

UCLF = the unit cost of a live firing including range costs, target simulation and post flight analysis support. (FY79$K)

2d. <u>Example Calculation</u>

Assume:

238 (17 squadrons x 14 pilots/sqn.) go through 1.5 hours of ACMR training annually

NLF = 10 per year

UCLF = 10K

range costs = 4K (4hrs. @ 1K/hr.)

target costs = 4K (TOW-assume 2 flights/target)

post flight anal. = 2K (2 manweeks @ $60K/year)

$$OT = 0.80 \times 357 + 10 \times 10$$

$$= 385.6 \ (FY79\$K)$$

3. ORGANIZATIONAL/AIRCRAFT INTERMEDIATE MAINTENANCE DEPARTMENT (AIMD) MAINTENANCE

3a. **Definition** - This is the cost of labor and consumable material required at the Squadron and the CVA/NAS Aircraft Intermediate Maintenance Department (AIMD) to perform maintenance on the missile and its associated equipment. The concept of the all-up-round (AUR) precludes this type of maintenance on the missile itself, but organizational and intermediate level maintenance is required on missile-dedicated aircraft equipment.

3b. **Discussion** - The current maintenance concept of Navy air-launched missiles is that of the all-up-round (AUR). What this means is that no maintenance is performed on the missile at the organizational level. If a missile fails a visual inspection or a built-in-test (BIT), it is packaged and returned to the Naval Weapons Station (NWS) for repair. No attempt is made to repair the missile on a carrier or at a Naval Air Station (NAS).

Costs do accrue to this element, however, when maintenance is required for missile system-dedicated hardware on the aircraft. Both the HARM and Harpoon systems require missile system-dedicated hardware on the launching aircraft. When such maintenance occurs, it can entail organizational labor and consumable materials to remove and replace the faulty equipment, and labor and consumable materials to repair the faulty equipment at the Aircraft Intermediate Maintenance Department (AIMD) aboard the carrier or at the NAS.

Data on missile system-dedicated aircraft hardware currently in the inventory can be obtained from the Maintenance and Material Management (3-M) System. The Fleet Weapon System Reliability and Maintainability Statistical Summary (MSOD 4790.A2142-01) contains data on mean-time-between-failure (MTBF)

and mean-time-to-repair (MTTR) by work unit code (WUC) for each aircraft type/
model/series (t/m/s) aircraft. This report can be obtained from the Maintenance
Support Office Department (MSOD) Mechanicsburg, PA, or by contacting Mr. R.
Schanamann (X-28781) of NAVMAT 0415.

Information regarding equipment not in the inventory can be obtained
from the weapon system Reliability Prediction Reports which are prepared for
each missile and contain projections for missiles and missile equipment relia-
bility. The reports can be obtained from Mr. F. Norton (X-27596) of NAVAIR 5205.

The estimation of aircraft operating and support costs is a rather
involved topic. The reader can get considerably more detail on this subject
by referring to "Naval Aircraft Operating and Support Cost Model - FY76 Revision,"
ASC R-116, March 1978.

3c. Cost-Estimating Relationship - The analytical representation of the compu-
tation of Organizational/AIMD Maintenance costs is given below:

$$OMC = OME \times EPR + CMA$$

$$OME = NA \times FHY/MTBF \times MTTR/1440$$

where,

OMC = the annual cost of organizational/AIMD maintenance. (FY79$K)

OME = the number of equivalent enlisted manyears required for
organizational/AIMD maintenance of missile system equipment.

EPR = the annual enlisted pay rate. (FY79$K = 9.517)

CMA = the annual cost of consumable material for missile-dedicated
aircraft equipment maintenance. (FY79$K)

NA = the number of aircraft carrying the missile-dedicated equipment.

FHY = the annual flying hours per aircraft.

MTBF = the mean-time-between-failure of the missile-dedicated equip-
ment. (hours)

$$MTTR = \text{the mean-time-to-repair the missile-dedicated equipment (hours)}.$$

It is again noted that the OME variable represents direct manpower at the organizational level. This variable, when summed with DE and DO (if other than zero) from Cost Element 1 - Handling and Inspection, is used to estimate Base Operating Support Costs and in turn, Replacement Training, Health Care and Personnel Support. This will be discussed in detail in each of the respective sections.

3d. <u>Example Calculation</u>

Case 1 - Aircraft contains missile-dedicated equipment.

Assume:

$$EPR = 9.5 \text{ (FY79$K)}$$

$$CMA = 0$$

$$NA = 204 \text{ aircraft}$$

$$FHY = 240 \text{ hours per year}$$

$$MTBF = 270 \text{ hours}$$

$$MTTR = 1.0 \text{ hour}$$

$$OME = 204 \times 240/270 \times 1/1440$$

$$= 0.13$$

$$OMC = 0.13 \times 9.5 + 0 = 1.2 \text{ (FY79$K)}$$

Case 2 - Aircraft does not contain missile-dedicated equipment.

$$OMC = 0$$

4. INTERMEDIATE MAINTENANCE

4a. <u>Definition</u> - Intermediate or Naval Weapons Station (NWS) maintenance is
the cost of personnel, consumable material and station overhead required to
perform missile and missile component checkout and repair at the Naval Weapons
Stations. This includes such procedures as the functional test of the assembled
round, fault isolation of the failed round, removal and replacement of faulty
major subgroups such as the flight control group of the guidance section, and
fault confirmation and other support from the Weapons Quality Evaluation Center
(WQEC). Exhibit III-3 taken from the AIM-7F MEA provides a graphic depiction of
the intermediate maintenance functions required for the AIM-7F.

4b. <u>Discussion</u> - The Maintenance Data Collection System (MDCS) for air-launched
missiles is maintained at the Fleet Analysis Center (FLTAC) in Corona, California
and tentative workload and budget data for NWS maintenance is available through
their Performance Monitoring System; but since it is only planning data, a
better source is Naval Air Systems Command, Operations, Navy, Budget Justification
Material. This material, which is prepared for each budget request by NAVAIR 4104,
contains detailed information about the unit cost and quantity of each type mis-
sile processed at the NWS. This data from the FY77, FY78, and FY79 submissions
is shown in Tables C-2 through C-5 of Appendix C.

In general, a missile requires NWS maintenance when one of three events
occur:

1. It is determined to have failed;
2. It has reached its afloat storage time limit or maintenance due
   date (MDD); or,
3. It has reached its shore storage time limit or maintenance due
   date (MDD).

EXHIBIT III-3

MAINTENANCE BLOCK DIAGRAM OF AIM-7F MISSILE
INTERMEDIATE LEVEL (NWS)

A missile failure can be ascertained in several ways. The most frequent method is via the avionics check of an uploaded missile, usually referred to as the BIT (built-in-test) or MOAT (missile-on-aircraft-test). A second method for determining failures is through visual inspection which may reveal missing or damaged parts. A final method of determining a failure is through some breach of maintenance or operational procedures. An example of this would be a missile that had been dropped or one that contained seawater in its sealed container.

The second source for NWS maintenance is when a missile reaches its MDD for afloat storage. When a carrier receives a shipfill of missiles for a deployment, a portion of the missiles is kept containerized in what is called deep storage. A missile is removed only when it is needed to replace a failed missile. The remainder of the missiles may remain in deep storage until a specific time limit is reached. When that occurs, the missiles must be returned to the NWS for test and recertification.

The third source for NWS maintenance is when a missile reaches its MDD for shore storage. Missiles in deep storage ashore are not subject to the ravages of salt air and sea motion and are therefore assumed to have better sur- vival rates than those stored afloat. Therefore they are sometimes afforded a longer interval between recertification.

It should be noted that for some missiles the current policy also im- poses a limit on the number of captive flights or captive flight hours, but this policy is under review. The replacement policy is one of "fly until die" or con- tinue to captive fly a missile until a failure is observed. Table C-6 of Appendix C, contains the current maintenance due policy for air-launched weapons.

Captive flight reliability data can be obtained from the FLTAC deployment reports mentioned in Section 1. For a missile not yet operational, a prediction of this reliability can be found in the Decision Coordinating Paper (DCP) which can be obtained from the program office. The DCP usually contains the proposed maintenance due policies, but if not, the program office can provide that information.

4c. <u>Cost-Estimating Relationship</u> - The NWS unit cost data found in Table C-5 of Appendix C was used to develop the following CER:

$$NWS = 0.312 + 2.561IRR + 0.004LWO$$
$$\qquad\qquad (1.18) \qquad (3.17)$$

$$\bar{R}^2 = 0.731$$

$$S.E.E. = 0.436$$

$$Det.of \ X'X = 0.728$$

$$F = 10.510$$

where,

NWS = the unit cost of NWS maintenance. (FY79$K)

IRR = the intermediate reject ratio, i.e., the percentage of missiles processed by the NWS which are determined to be failures and are sent to the depot for repair.

LWO = the launch weight of the missile less the ordnance weight. (kilograms)

DATA BASE

Missile	NWS (FY79$K)	IRR	LWO (KG)
Sidewinder	1.07	0.13	77.00
Sparrow (AIR)	1.84	0.30	200.00
Walleye I	1.15	0.07	225.00
Walleye II	1.34	0.09	182.00
Shrike	1.36	0.22	137.00
Standard Arm	3.48	0.30	548.00
Phoenix	1.77	0.25	421.00
Harpoon	2.67	0.19	375.00

The use of the intermediate reject ratio as an explanatory variable for estimating unit intermediate maintenance costs may, at first, seem recursive, but it makes sense not only statistically, but intuitively as well, once the details of NWS funding are understood. Simply speaking, the Naval Weapons Stations negotiate a unit fixed price with NAVAIR for the repair of each type missile. Funding then amounts to the unit price times the number processed. Since the unit price is applicable both to missiles which pass initial tests and are recertified after minimal maintenance, and to missiles which fail initial tests, require retest, dissassembly, fault isolation, etc., it is obvious that the greater the percentage of failures, the higher the unit price will eventually be.

To compute the intermediate reject ratio requires the computation of each of the various sources of maintenance requirements - observed failures, maintenance due for afloat storage, and maintenance due for shore storage, each having its own failure rate or reject rate. The analytical representation is:

$$IRR = \frac{AF \times AFRR + MDSA \times MDSARR + MDSS \times MDSSRR}{NWSWL}$$

where,

IRR = the intermediate reject ratio, i.e., the percentage of missiles processed by the NWS which are determined to be failures and are sent to the depot for repair.

AF = the annual NWS workload resulting from missile failures, determined by BIT check and visual inspection.

AFRR = the failure rate at the NWS of missiles which were returned to the NWS as observed failures in the fleet.

MDSA = the annual NWS workload resulting from missiles stored afloat which reach their maintenance due date.

MDSARR = the failure rate at the NWS of missiles which were returned
to the NWS because the afloat storage maintenance due date
had been reached.

MDSS = the annual NWS workload resulting from missiles stored
ashore which reach the maintenance due date.

MDSSRR = the failure rate at the NWS of missiles which were returned
to the NWS because the shore storage maintenance due date
had been reached.

NWSWL = the annual NWS workload; i.e., the number of missiles of a
particular type which undergo NWS maintenance in a year.

Data for the three failure rates is usually contained in the DCP and/or the
Reliability Prediction Report for each missile under development. NWS reject
rates for missiles in the fleet are recorded by the FLTAC Performance Monitoring
System (PMS) and can be requested through Mr. Koniak of NAVAIR 4104. Table C-7
of Appendix C contains the most recently ava   eject ratio data.

The degree of sophistication us   ce the NWS workload can
vary greatly. If feasible, one can employ a   _tion in which every missile
is tracked and failures are determined stochastically with predetermined failure
rates and in accordance with one or more assumed operational scenarios involving
deployment schedules, cross-decking policies, captive carry rates and many other
factors. On the other hand, the analyst can simply obtain an estimate by anal-
ogy using the NWS workload data in Tables C-2, C-3, and C-4 of Appendix C.

One methodology, which is a compromise between the two previously
mentioned, is to estimate the workload resulting from each of the three sources
mentioned earlier. An analytical representation of this methodology is as
follows:

$$NWSWL = AF + MDSA + MDSS$$

$$AF = CF \times NM \times CFD/CFFR$$

$$MDSA = (ANSA - AF) \times \frac{1}{ASR}$$

$$MDSS = ANSS \times \frac{1}{SSR}$$

where,

NWSWL = the annual NWS workload; i.e., the number of missiles of a particular type which undergo NWS maintenance in a year.

AF = the annual NWS workload resulting from missile failures, determined by BIT check and visual inspection.

MDSA = the annual NWS workload resulting from missiles stored afloat which reach their maintenance due date.

MDSS = the annual NWS workload resulting from missiles stored ashore which reach the maintenance due date.

CF = the total annual number of captive flights (also used in Element 1).

NM = the number of missiles per captive flight.

CFD = the average captive flight duration (in hours).

CFFR = the captive flight failure rate (MTBF in hours).

ANSA = the average number of missiles stored afloat.

ASR = the afloat storage recertification time (maintenance due date - in years).

ANSS = the average number of missiles stored ashore.

SRR = the shore storage recertification time (maintenance due date - in years).

Therefore, the NWS cost can be estimated as the workload multiplied by the unit cost.

$$TNWS = NWS \times NWSWL$$

where,

TNWS = the total NWS maintenance cost. (FY79$K)

NWS = the unit cost of NWS maintenance. (FY79$K)

NWSWL = the annual NWS workload; i.e., the number of missiles of a particular type which undergo NWS maintenance in a year.

4d. Example Calculation

Unit Cost:

Assume a missile with the following characteristics:

LWO = 150kg

IRR = 0.12

NWS = 0.312 + 2.561(0.12) + 0.004(150)

= 1.22 (FY79$K)

Workload:

Assume:

ANSA = 600 (5 carriers x 120 shipfill) missiles

ANSS = 3400 missiles

CF = 1680 (as computed in Element 1)

NM = 1

ASR = 1.75 years

SSR = 4 years

CFFR = 300 hours

CFD = 2.5 hours

AF = 1680 x 2.5/300 = 14 missiles

MDSA = (600 - 14)/1.75 = 335 missiles

MDSS = 3400/4 = 850 missiles

NWSWL = 14 + 335 + 850 = 1199 missiles per year

Total NWS cost = 1199 x 1.22 = $1462.8 (FY79$K)

5. BASE OPERATING SUPPORT

5a. <u>Definition</u> - Base Operating Support (BOS) is the cost of installation personnel and material necessary to directly support missile handling and inspection personnel. Examples of installation functions which directly support the unit include food services, custodial services, supply, motor pool, payroll, ADP and communication operations. It also includes a proportional share of work center costs such as real property maintenance, etc.

5b. <u>Discussion</u> - Since it is often difficult to determine the variable impacts on base operating support costs of the addition or deletion of a force unit such as a missile or an entire missile system, the methodology used in the <u>Navy Resource Model (NARM) Program Factors Manual</u>[1] was adopted to provide an estimate for Base Operating Support costs as well as several other subsequent elements which are similarly general in nature. A simplified explanation of the NARM methodology is that it identifies total support resources (O&M funds and manpower) of a specific type from the Navy budget and allocates those resources back to the force units based on some proxy variable or variables which are chosen to approximate that force unit's demand for support. The usual proxy variable is direct manpower (in the case of missiles, Handling and Inspection and Organizational/AIMD Maintenance manpower). In each succeeding case where NARM methodology is used to estimate costs, it is identified and the methodology, factors and proxy variables are given.

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[1]<u>Navy Program Factors Manual</u>, (OPNAV-90P-02A), Volumes I and II, 31 August 1977.

For BOS the computation is done in the following manner. The annual costs and manpower allowances found in the Navy budget, which are contained in program elements 24611N, 24612N, 24613N, 24614N, 24615N, 24617N, 24618N and 72827N are summed and divided by three, because only one-third of the total BOS resources are considered variable with the forces. The one-third of the resources which is to be allocated is done so based on the number of direct operating personnel associated with each system, i.e., the more personnel required to operate and support a weapon system, the more base services are required. BOS services consist of officer personnel, enlisted personnel and O&MN funds. The factors used to make this allocation are not found explicitly in the Factors Manual. Those factors used in the most recent edition, 31 August 1977, are given in this report, and subsequent revisions can be obtained from Ms. Ruth, Op-901, (X-55038).

5c. <u>Cost-Estimating Relationship</u> - The computation is as follows:

$$BO = 0.0014TDP$$

$$BE = 0.0178TDP$$

$$BOM = 0.4946TDP$$

$$BOS = (BO \times OPR) + (BE \times EPR) + BOM$$

where,

BO = the number of base operating officers necessary to provide BOS services to missile system personnel.

TDP = the number of total direct personnel (officers and enlisted) involved in operating and supporting the missile system. This is usually an equivalent number of personnel, (e.g., two officers half-time equal one officer) required in Element 1 - Handling and Inspection, and Element 3 - Organizational/AIMD Maintenance and is equal to the sum of DE and DO (from Element 1) and OME (from Element 3, Section 3, 3c.)

BE = the number of base operating enlisted personnel necessary to provide BOS services to missile system personnel.

BOM = the O&M funds required to provide BOS services to missile
system personnel. (FY79$K)

BOS = the total cost (O&MN and MPN) of base operating support. (FY79$K)

OPR = the officer pay rate. (FY79$K = 22.141)

EPR = the enlisted pay rate. (FY79$K = 9.517)

It is important to make note here of three important variables - the
number of direct enlisted (DE + OME) plus base operating enlisted (BE), hereafter
referred to as direct and base operating enlisted (DBE); the number of direct
officers (DO) plus base operating officers (BO), hereafter referred to as direct
plus base operating officers(DBO); and the total of the two, hereafter referred
to as direct and base operating total (DBT). These variables are required by
the NARM methodology and are used to compute costs for Elements 11 - Replacement
Training, 12 - Health Care, and 13 - Personnel Support.

The equations are given below:

DBE = DE + OME + BE

DBO = DO + BO

DBT = DBE + DBO

where,

DBE = the total number of enlisted personnel, direct plus base
operating, required to operate and provide base support to
the missile system.

DE = the number of equivalent direct enlisted required
for handling and inspection tasks (from Element 1, Section III,1c.)

OME = the number of equivalent enlisted required for
Organizational/AIMD Maintenance of missile system equipment.

BE = the number of base operating enlisted personnel necessary to
provide base operating support services to missile system
personnel.

DBO = the total number of officer personnel, direct plus base operating, required to operate and provide base support to the missile system.

DO = the number of equivalent direct officers required for handling and inspection tasks.

BO = the number of base operating officers necessary to provide base operating support services to missile system personnel.

DBT = the total number of personnel, officers and enlisted, direct plus base operating required to operate and provide base support to the missile system.

5d. Example Calculation

Assume:

DE = 5.8 (from Element 1, Section III, 1d.)

DO = 0 (from Element 1, Section III, 1d.)

OME = 0.1 (from Element 1, Section III, 1d.)

TDP = 5.9

BO = 0.0014(5.9) = 0.0 officers

BE = 0.0178(5.9) = 0.1 enlisted

BOM = 0.495(5.9) = 2.9 O&M (FY79$K)

BOS = 0 x 22.1 + 0.1 x 9.5 + 2.9 = 3.9 (FY79$K)

also:

DBE = 5.8 + 0.1 + 0.1

= 6.0 enlisted

DBO = 0 + 0

= 0 officers

DBT = 6.0 + 0 = 6.0 total personnel

6. DEPOT MAINTENANCE

6a. <u>Definition</u> - Depot Maintenance is the cost of manpower, material, and overhead needed to perform missile, missile component and support equipment maintenance at Navy and Contractor repair facilities. Exhibit III-4 taken from the AIM-7F MEA provides a graphic depiction of the depot maintenance functions for the AIM-7F missile. In addition to maintenance of missiles, depot maintenance funding pays for a number of types of support other than repair of missile sections such as:

  1. Mobile Missile Maintenance Unit (MMMU) operations,

  2. repair of missile containers, (material denoted by Aviation Supply Office (ASO) cognizance code-2E),

  3. repair of missile explosive devices (material denoted by ASO cognizance code-4E),

  4. repair of air-launched missile repairable components (material denoted by ASO cognizance code-6E),

  5. repair and calibration of test equipment and other GSE.

6b. <u>Discussion</u> - Data for depot repair costs of air-launched missiles and missile equipment is available from several sources. The first source, FLTAC air-launched missile MDCS, contains a large amount of logistic information such as depot level parts replacement rates for the flight control and seeker sections, klystron replacement rates, analysis of age sensitive components, and many other details. The second source, <u>Industrial Performance Summary of the Naval Air Rework Facilities</u> provides complete data on the rework of the missiles at the

48
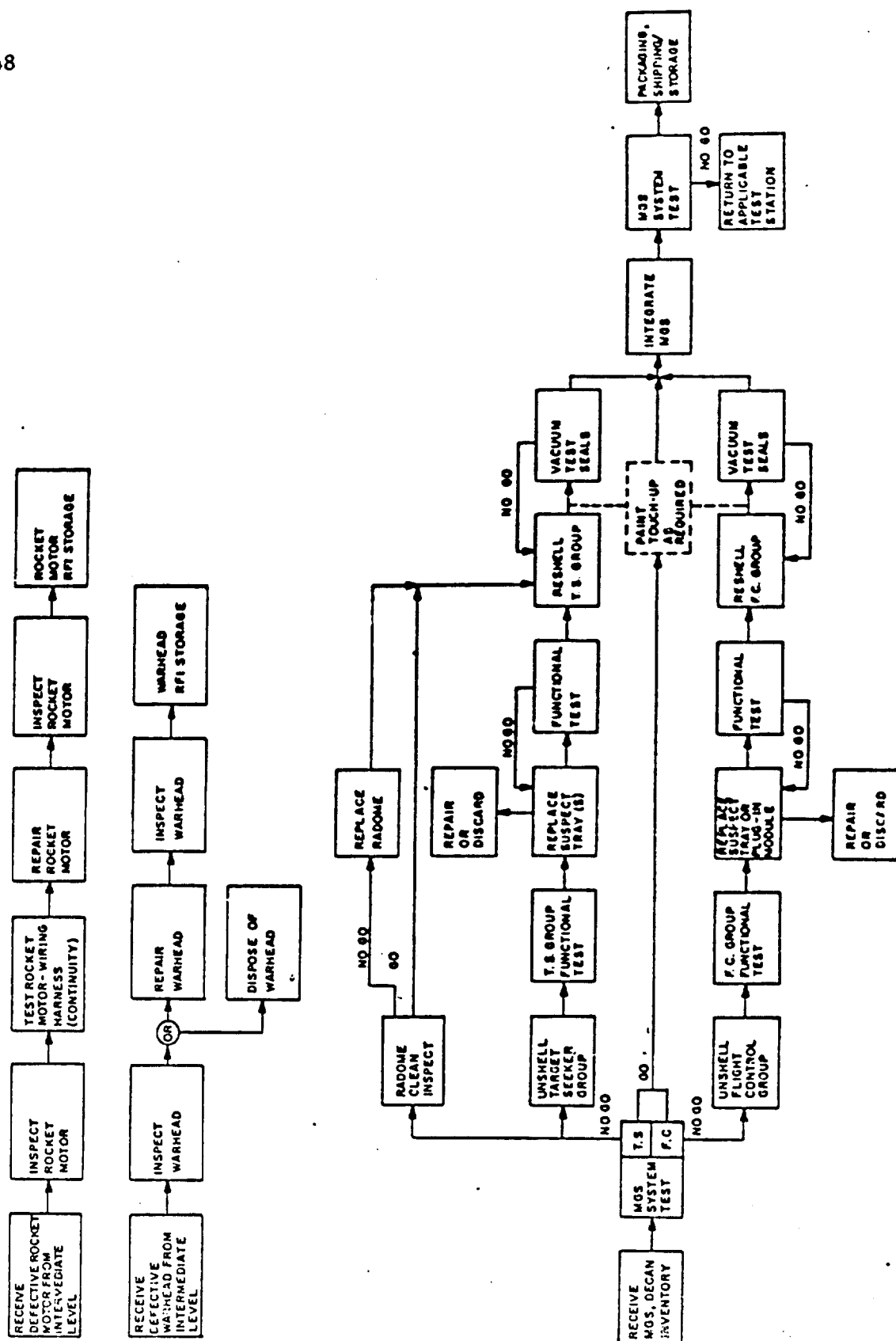
EXHIBIT III-4

MAINTENANCE BLOCK DIAGRAM OF THE AIM-7F MISSILE – DEPOT LEVEL

Naval Air Rework Facilities (NARF's). Neither of these sources however,
provides complete depot costs since neither addresses the miscellaneous rework
previously mentioned or the rework of rocket motors. In order to obtain this
information, one must go to the third source, the Budget Justification Material
prepared by NAVAIR 4104, obtainable from Mr. Koniak (X-29773). Since NAVAIR
4104 budgets for, and funds all depot rework for air-launched missile systems,
the budget back-up provides a complete funding profile of all depot costs.
Tables C-8 through C-18 of Appendix C contain copies of the depot maintenance
budget back-up sheets from the FY77, FY78 and FY79 submissions. Each table
contains the data for one fiscal year (or transition quarter) as it appeared
in the budget submission. Table C-19 contains a history of total depot costs
expressed as a unit cost based on the guidance and control (G&C) section work-
load. This is done to facilitate cost estimating by maintaining compatability
with the NWS reject ratio. Table C-20 contains the depot unit cost of repair
of the G&C section. In the cases (Shrike and Phoenix) where there are actually
two separate sections (a guidance and a control section), the unit cost is ex-
pressed on the basis of the guidance section workload. Table C-21 contains
the depot manhours required to repair a G&C section for those missiles reworked
at the NARF's. It also contains the NARF labor rates for the missile work
centers. Table C-22 contains unit costs for depot (NOS Indianhead) repair of
rocket motors, commercial depot level repair cost and other depot costs. Other
depot costs consist of repair of repairables, container repair, ground support
equipment repair and Mobile Missile Maintenance Unit (MMMU) operations. Although
the specific breakdown of these components is not available, it was learned from

NAVAIR that repair of repairables comprised 70% of other depot costs in FY78, 38% in FY77 and 42% in FY76.

Historical depot workload data is also contained in Tables C-8 through C-18 of Appendix C. The estimation of future depot workloads can be easily accomplished by taking the three sources of NWS workload (from Element 4) and multiplying each by its respective NWS failure rate (also from Element 4). This provides an estimate of the number of sections requiring depot repair. It should be pointed out that this estimate is not technically precise since it is possible that a rejection at the NWS may produce two or more sections which require depot repair and the currently available data does not permit one to track an occurence of this kind. Fortunately, this problem is not of a magnitude sufficient to affect cost estimating significantly and is mentioned only for the background knowledge of the reader.

6c. Cost-Estimating Relationship - Two CER's were developed for estimating depot costs - the first estimates the total depot unit cost, while the second estimates only the G&C unit repair cost. The CER for total depot cost is as follows:

$$DC = DUC \times WL$$

$$WL = NWSWL \times IRR$$

$$DUC = 1.251 + \underset{(1.52)}{0.324MS} + \underset{(4.99)}{0.013CAC}_{1000}$$

$$\bar{R}^2 = 0.834$$

$$S.E.E. = 0.890$$

$$Det.of\ X'X = 0.949$$

$$F = 16.131$$

where

DC   = the total annual depot cost. (FY79$K)

DUC = the total depot unit cost for a particular type missile
       (FY79$K)

WL   = the depot workload; i.e., the number of G&C sections processed.

NWSWL = the annual NWS workload; i.e., the number of missiles of a
        particular type which undergo NWS maintenance in a year.

IRR = the intermediate reject ratio; i.e., the number of missiles
       failed by the NWS and forwarded to the depot for repair
       divided by the total number processed by the NWS.

MS   = the maximum speed of the missile in free flight. (mach)

CAC_{1000} = the cumulative average hardware cost of the first one
       thousand missiles procured. (FY79$K)

DATA BASE

Missile	DUC (FY79$K)	MS (mach)	CAC_{1000} (FY79$K)
Sidewinder	3.54	4.0	35.4
Sparrow (AIR)	3.97	2.5	129.6
Walleye I	2.19	1.0	47.3
Walleye II	2.85	1.0	56.1
Shrike	1.12	2.0	48.7
Phoenix	6.90	5.0	335.2
Harpoon	5.94	0.8	340.9

The Standard ARM observation was removed from the data base because
it was felt that the extremely low volume of depot repair was resulting in an
unusually high unit cost.

If one wishes to estimate only the unit cost of repair of the G&C
section, the following CER may be used:

$$DGC = -0.728 + 0.018LWO$$
$$(5.43)$$

$$\bar{R}^2 = 0.803$$

$$\text{S.} \llcorner \text{.E.} = 1.404$$

$$\text{Det.of } X'X = 1.000$$

$$F = 29.486$$

where,

DGC = the depot unit cost of rework of a missile G&C section. (This does not include repair of G&C repairables.) (FY79$K)

LWO = the launch weight of the missile less the ordnance weight. (kilograms)

DATA BASE

Missile	DGC (FY79$K)	LWO (kg)
Sidewinder	2.1	85.0
Sparrow	3.1	200.0
Walleye I	1.8	225.0
Walleye II	2.5	182.0
Shrike	1.3	137.0
Standard Arm	9.4	548.0
Pheonix	8.7	421.0
Harpoon	4.1	375.0

This CER would also be improved by omitting the Sidewinder observation, but the improvement is only slight since most of the unexplained variation is in the depot rocket motor and depot other categories. If this equation is utilized, the analyst must explicitly treat the other depot costs - repair of rocket motors, repairable material, containers and other costs. This may be done by analogy using Table C-22.

6d. Example Calculation

Assume:

$$MS = 4.5 \text{ mach}$$

$$CAC_{1000} = 145 \text{ (FY79\$K)}$$

$$\text{NWSWL} = 1,199$$

$$\text{IRR} = 0.12$$

$$\text{WL} = \text{NWSWL} \times \text{IRR} = 144$$

$$\text{DUC} = 1.251 + 0.324(4.5) + 0.013(145)$$

$$= 4.6 \ (\text{FY79\$K})$$

$$\text{DC} = 4.6 \times 144 = 662.4 \ (\text{FY79\$K})$$

7. SUPPLY DEPOT OPERATIONS

7a. __Definition__ - This is the cost of manpower and material needed to buy, store, package, manage and control supplies, spares and repair parts used in operating and maintaining missiles, missile components and support equipment. When a new missile system is introduced into the force, spare parts are procured to sustain missile operations. These parts are introduced into the supply system and resources are expended to manage, store, distribute, package and crate both the spares inventory and other common supply items which support missile system personnel.

7b. __Discussion__ - This cost is computed for the __Navy Resource Model Program Factors Manual__ by taking the costs contained in program element 71111N - Supply Depot Operations of the budget and allocating to force units on the basis of direct requirements of manpower and operating funds, i.e., MPN, O&MN, and WPN.

7c. __Cost-Estimating Relationship__ - The equation for estimating Supply Depot Operations is:

$$SDO = 0.025DR$$

where,

SDO = the annual cost of Supply Depot Operations required to support a weapon system. (FY79$K)

DR = the direct requirements of manpower and operating funds represented by the total cost of Elements 1, 3, 4 and 6. (FY79$K)   (HI + OMC + NWS + DC)

7d. __Example Calculation__

Assume:

HI = 55.1   (total cost - Element 1, Section III 1d.)

OMC = 1.2   (total cost - Element 3, Section III 3d.)

$$\text{NWS} = 1487.8 \quad \text{(total cost - Element 4, Section III, 4d.)}$$

$$\text{DC} = 662.4 \quad \text{(total cost - Element 6, Section III, 6d.)}$$

$$\text{DR} = 55.1 + 1.2 + 1462.8 + 662.4 = 2181.5$$

$$\text{SDO} = 0.025 \times 2181.5$$

$$= 54.5 \text{ (FY79\$K)}$$

8. TECHNICAL SUPPORT

Technical Support is the cost of a number technically oriented programs usually centrally managed by the Systems Command or one of its field activities. Each of the programs, which are listed below, will be identified and discussed separately.

8.1 Fleet Support

8.2 Engineering Support

8.3 Quality Evaluation

8.4 Program Management

8.1 FLEET SUPPORT

8.1a. <u>Definition</u> - Fleet Support is the cost of on-site technical personnel
(Navy civilians) who provide technical advice and assistance in the oper-
ation and maintenance of the weapon system. These "tech. reps." deploy with
the units and serve as advisors and liaison for maintenance, configuration,
training and many other problem areas.

8.1b. <u>Discussion</u> - Fleet Support is budgeted and funded by NAVAIR 4104 and
Mr. Koniak (X-29773) is the responsible individual. Cost data for Fleet
Support are found in the Budget Justification Material prepared by NAVAIR 4104
and are presented in Table C-23 of Appendix C.

8.1c. <u>Cost-Estimating Relationship</u> - The data from Table C-23 was used to
develop this CER for Fleet Support costs:

$$FS = 64.307 + 3.119PI + 113.530AAD$$
$$(2.83) \quad (4.25)$$

$$\bar{R}^2 = 0.800$$

$$S.E.E. = 36.231$$

$$Det. \text{ of } X X = 0.980$$

$$F = 14.995$$

Where,

FS = the annual cost of Fleet Support for a particular missile
type (FY79$K)

PI = the percentage of the air launched missile inventory
represented by the missile

AAD = a dummy variable which takes the following values:

0, if the missile is an air-to-surface missile

1, if the missile is an air-to-air missile

DATA BASE

Missile	FS (FY79$K)	PI[1] % (FY79 Base)	AAD
Sidewinder	271	17.6	1
Sparrow	271	17.3	1
Walleye I	117	22.5	0
Walleye II	52	3.6	0
Shrike	192	25.4	0
Standard Arm	107	2.5	0
Phoenix	170	7.3	1
Harpoon	98	3.8	0

The data used in this CER is the average of FY76 from the FY78 submission plus the three years (FY77-79) contained in the FY79 submission.

8.1d. Example Calculation

Assume:

PI = 20%

AAD = 1

FS = 64.317 + 4.229(20) + 113.530(1)

+ 262.4 (FY79$K)

---

[1]The variable PI has been adjusted from the values shown in Exhibit IV-1 to reflect only those missiles that have Fleet Support funding in FY1979.

8.2 ENGINEERING SUPPORT

8.2a <u>Definition</u> - The cost of Engineering Support is comprised of two major areas - maintenance engineering and design engineering. The former consists of efforts at the various Naval engineering activities in support of the missile maintenance system and is funded through NAVAIR 410, while the latter is concerned with engineering for the missile itself, i.e., design and configuration matters, and is funded by the NAVAIR 510. These engineering functions include revisions and additions to the Integrated Logistics Support Plan (ILSP) necessitated by configuration changes, revisions to the maintenance concept, or any other change instituted to correct a problem in the fleet. In other words, Engineering Support funding pays for follow-on Integrated Logistics Support (ILS).

8.2b <u>Discussion</u> - The NAVAIR 410 portion is printed in the Budget Justification Material and is summarized in Table C-24 of Appendix C. The NAVAIR 510 portion is not specifically identified in the budget but was obtained from NAVAIR 510, and is shown in Table C-25 of Appendix C. For further information contact Mr. Koniak (X-29773) for the NAVAIR 410 portion and Captain Glunt (X-28571) or Mr. Cooper (X-28620) for the NAVAIR 510 portion.

8.2c <u>Cost-Estimating Relationship</u> - The following CER can be used to estimate the total cost of Engineering Support:

$$ES = 80.950 + 4.306FS$$
$$(3.96)$$
$$\bar{R}^2 = 0.677$$
$$S.E.E. = 233$$
$$Det. of\ X'X = 1.000$$
$$F = 15.649$$

where,

ES = the annual cost of Engineering Support (design engineering and maintenance engineering). (FY79$K)

FS = the annual cost of Fleet Support for a particular missile type (FY79$K).

DATA BASE

Missile	ES (FY79$K)	FS (FY79$K)
Sidewinder	1,431	271
Sparrow	1,241	271
Walleye I	347	117
Walleye II	181	52
Shrike	657	192
Standard Arm	709	107
Phoenix	747	170
Harpoon	857	98

The data show above is the sum of the four-year average funding level (FY76-FY79) for NAVAIR 410 and NAVAIR 510 Engineering Support.

8.2d Example Calculation

Assume:

FS = 262.4 (from Element 8.1, Section III, 8.1d.)

ES = 80.950 + 4.306(262.4)

= 1210.8 (FY79$K)

8.3 QUALITY EVALUATION

8.3a **Definition** - Quality Evaluation is the cost of the Navy Weapons Quality Program whose purpose is to monitor the status and condition of the air-launched weapons stockpile. Principal activities include maintenance/reliability/ performance trend analysis, calibration of test equipment, destrucitve testing of missile sections, certification of NWS failures and related data collection and analysis.

8.3b **Discussion** - Data for Quality Evaluation (QE) were received from Mr. Sanders, NAVAIR 4104 (X-29828) and are shown in Table C-26 of Appendix C. The data were adjusted per Mr. Sanders instructions to include the cost of the Special Interface Gauges Program. Quality·Evaluation funds were also used to support the development of the air-launched weapons reporting system at FLTAC, Corona, California, but this was not factored into the data since it is not a recurring function.

8.3c **Cost-Estimating Relationship** - The estimating equation for Quality Evaluation is as follows:

$$QE = 109.559 + 6.785PI + 171.660AAD$$

$$\bar{R}^2 = 0.605$$

$$S.E.E. = 85.768$$

$$\text{Det of } X'X = 0.98$$

$$F = 6.369$$

Where,

QE = the annual cost of Quality Evaluation (FY79$K)

PI = the percentage of air-launched missile inventory represented by the missile

AAD = A dummy variable which takes the following values:

0, if the missile is an air-to-surface missile.

1, if the missile is an air-to-air missile.

DATA BASE

Missile	QE (FY79$K)	PI[1] % (FY79Base)	AAD
Sidewinder	465	17.6	1
Sparrow	397	17.3	1
Walleye I	176	22.5	0
Walleye II	88	3.6	0
Shrike	324	25.4	0
Standard Arm	90	2.5	0
Phoenix	268	7.3	1
Harpoon	262	3.8	0

One might note that since Quality Evaluation is estimated with the same independent variables as Fleet Support, the two might be strongly correlated. This is in fact, true and to express QE as a function of FS makes sense not only analytically but logically. If the fleets are requiring a lot of on-site support (FS) for a missile, it obviously follows that many of those problems will be studied in the QE centers. The relationship is:

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[1]The variable PI has been adjusted from the values shown in Exhibit IV-1 to reflect only those missiles that have Quality Evaluation Funding.

$$QE = 10.30 + 1.05 \ FS$$
$$(7.36)$$

$$\bar{R}^2 = 0.883$$

$$S.E.E. = 51.450$$

$$Det \ of \ X'X = 1.000$$

$$F = 54.20$$

Where,

QE = the annual cost of Quality Evaluation (FY79$K).

FS = the annual cost of Fleet Support for a particular missile type (FY79$K).

DATA BASE

Missile	QE FY79$K)	FS (FY79$K)
Sidewinder	465	271
Sparrow	397	271
Walleye I	176	117
Walleye II	88	52
Shrike	324	192
Standard Arm	90	107
Phoenix	268	170
Harpoon	262	98

8.3d Example Calculation

Assume:

$$AAD = 1$$
$$PI = 20\%$$

$$QE = 109.569 + 6.785(20 + 171.660 \ (1)$$
$$= 417.0 \ (FY79\$K)$$

8.4   PROGRAM MANAGEMENT

8.4a   <u>Definition</u> - Program Management is the O&S cost of missile-specific project management both at Systems Command level and below.

8.4b   <u>Discussion</u> - Since the bulk of Program Management costs reside in the procurement phase of life cycle costing, it is important that costs shown in this element refer only to system activities of an operating or support nature. These costs are not routinely collected but can usually be estimated from discussions with program office personnel.   A list of the missile program offices is given below:

MISSILE PROJECT OFFICES

Number	Title	Missile	Telephone
PMA 241	F14/Phoenix	Phoenix	28283
PMA 242	Defense Suppression Systems	Shrike, Standard ARM, HARM, Walleye I & II	23352
PMA 258	Harpoon	Harpoon	23340
PMA 259	Infrared Missiles	Sidewinder	20914
PMA 252	Sparrow III	Sparrow	28228
PM 3	Tomahawk	Tomahawk	28025

8.4c   <u>Cost-Estimating Relationship</u> - Program Management costs are computed in the following manner:

$$PM = \Sigma\ NMP_i \times CP_i$$

where,

PM = the annual cost of Program Management (FY79$K).

NPM_i = the number of program management personnel in the ith pay grade

CP_i = the annual cost of paying one person in the ith pay grade (FY79$K).

It should be noted that the above equation relates only to direct pay and allowances of the manpower and has no provision for the overhead or "support tail." It would be possible to include the manpower with the Handling and Inspection, Organizational/AIMD Maintenance and Base Operating Support manpower and use the NARM factors to compute the general support costs. But since Program Management personnel are not in the fleet, the NARM factors, which are based on support of personnel in the fleet, are not appropriate. Just how to preperly define and compute the total cost of manpower (especially headquarters manpower) is a subject that is currently being widely discussed and studied. In the meantime the analyst can estimate this cost heuristically or include only direct pay and allowances. The sensitivity of total O&S costs to this topic is very slight.

Direct pay and allowance can be computed determning how many individuals of each rank/grade/step, etc. are involved in O&S activities and multiplying by the respective rates from a current pay schedule. Typically, a civilian professional in a project office would hold a grade approximating a GS 12, Step 5, while a clerical worker would hold a grade approximating a GS 6, Step 3.

8.4d Example Calculation

Assume the following personnel are concerned with O&S program management activities:

      1 Military Officer $22.1

      2 Civilian Professional $24.8

      1 Civilian Clerical $11.8

$$PM = 1 \times 22.1 + 2 \times 24.8 + 1 \times 11.8$$

$$= 83.5 \ (FY79\$K)$$

9. TRANSPORTATION

9a. __Definition__ - This is the cost of Second Destination Transportation which consists primarily of commercial transportation of missiles or missile sections from the Naval Weapons Stations to the depots and back. There are also other reasons which require the transporting of missiles. For example, the current environment in which certain missile types are in short supply often causes imbalances between loadout requirements and inventory. These imbalances are solved by transhipping available missiles to the site where they are required.

9b. __Discussion__ - Current plans call for the transferring of the missile depot repair capability of NARF Norfolk to NARF Alameda at the end of FY1979. This will make NARF Alameda the single site for depot repair of air-launched missile guidance and control sections and will significantly add to the cost of transportation. Unfortunately, the process required to precisely determine commercial transportation costs of missiles and missile sections is quite complicated. Rates vary with the distance traveled, the type of cargo (explosive components cost more), the number of hundredweight to be shipped, the level of security required, the routing of the shipment. and many other considerations. The situation is further complicated by the fact that in some situations (usually short hauls) sections are not transported commercially, but by organic Navy vehicles.

It is obvious that an exact representation of how transportation costs are incurred is much too involved and tedious for the purposes of this model; therefore, a sample of rates, which have been chosen as representative, are presented. In addition, factors representing the average cost of inland

commercial cargo transportation in the FY77 Budget Justification Material is given to use in situations where transportation costs need not be estimated with such precision. The analyst should realize that this is a very generalized factor and is comprised of mostly INERT material. The factor, $0.1297 per kilogram transported (FY79$K), is taken from Table C-27 of Appendix C, which shows a cost of $42,226 (FY77$K) for transportation of 408,802 short-tons of material. This results in the previously mentioned factor when escalated to FY79$ and adjusted to metric weight. In addition other generalized factors based specifically on air-launched missile transportation costs are given later in this section.

For exercises which require a more detailed analysis of transportation costs, the reader can refer to Tables C-28 through C-37 of Appendix C. Each table contains transportation costs quotes from the Military Traffic Management Command (MTMC) Bayonne, New Jersey. Mr. Norman Roberts of NAVAIR 412 (X-20028) who is the NAVAIR contact for transportation costs was extremely helpful in obtaining the rate quotes from MTMC and in interpreting them.

Generally speaking, rate quotes were requested for four different types of material, for one-way trips involving ten combinations of origins and destinations, and for a number of different load sizes. Information regarding other charges involved in transporting missiles was also requested. The four types of material with simplified definitions are given below:

Class A Explosive - Explosive material causing maximum hazard such as a missile warhead or all-up-round.

Class B Explosive - Material which is typified by rapid combustion rather than detonation such as a missile rocket motor.

Class C Explosive - Devices that contain Class A or Class B explosive material but in restricted quantities. The Sidewinder guidance and control unit falls into this class.

INERT - No explosive material. The Sparrow guidance and control unit falls into this class.

The routes which were chosen and the tables which contain the rate quotes for those routes are given below:

Table	Origin	Destination
C-28	NWS Concord, CA	NOS Indianhead, MD
C-29	NWS Concord, CA	NWS Earle, NJ
C-30	NARF Alameda, CA	NWSC Crane, IN
C-31	NARF Alameda, CA	NWS Yorktown, VA
C-32	NARF Alameda, CA	NAS Miramar, CA
C-33	NARF Alameda, CA	NWS Seal Beach, CA
C-34	NWS Charleston, SC	NARF Alameda, CA
C-35	NWS Yorktown, VA	NARF Alameda, CA
C-36	NWS Yorktown, VA	NOS Indianhead, MD
C-37	NWS Yorktown, VA	NWS Charleston, SC

The routes were chosen to represent as large a portion of actual traffic as feasible and still demonstrate the many complexities of the rate structure. Several cross country routes were given (Tables C-28, C-29, C-31, C-34 and C-35) and the rates are somewhat puzzling. Although the distances were virtually the same, the truckload rate for 38,000 pounds varies more than 40 percent from the low rate $10.32 per cwt. to the high rate $14.75 per cwt. If one wishes to consider NWS Concord, CA to NWSC Crane, IN, a cross country route (2,255 miles) then the rate drops to $5.44 per cwt. Four short routes were included, two intra-state (C-32 and C-33) and two interstate (C-36 and C-37). The shorter routes seem to offer a greater variety of rates and those rates also vary significantly. For example, a truckload of Class A Explosive material going from NARF Alameda to NWS Seal Beach (417 miles) costs $0.95 per cwt., while a slightly larger truckload going from NWS Yorktown to NOS Indianhead (170 miles) costs $2.18 per cwt. The rates, which may be affected

by intrastate vs. interstate considerations or possibly by east coast vs. west coast considerations do not adhere to a consistent pattern. One might infer that the volume of traffic is an important factor since shipments to the Navy Propellant Plant (C-35) seem to enjoy a favorable rate. One route was requested twice, once with the origin and destination reversed (C-31 and C-35) to see if that affected the rates. Generally speaking, it did not, although there is one difference in the truckload rates for INERT material. It had been learned in discussions with NAVAIR personnel that in some cases rates do vary over the same routes, when different origins are considered. Two final examples of puzzling data are contained in Table C-35 where the quoted truckload (TL) rate was higher than the less truckload (LTL) rate; and in Table C-28 where the rate for INERT material was higher than for Class A Explosive material.

In summary, it appears that the primary cost influence on transportation is the size of the shipment, followed by the distance shipped, the type of material and security required. Obviously, local competitive factors as well as many other considerations cause abberations in the data, some of which are quite significant. The level of security (Signature Security, Dual Driver Protective Service) is determined by the asset managers and also can be an important cost consideration. It is up to the user of this manual to select certain rates as representative for each analysis and use them as estimates. The analyst is cautioned that the variations in the rate structures have caused variations in format in the ten tables (C-28 through C-37) and the reader should exercise caution in extracting data from them. One final technical

note is that these tables on transportation (C-28 through C-37) are given in non-metric units while the rest of the report is metric. The exception was made in order to avoid confusion in a subject area which is already quite complicated. Since the Navy and the trucking industry do not use the metric system in computing or discussing rates, it was not used in this section. Metric conversion factors are given at the bottom of each of the tables containing transportation rates.

Based on Tables C-28 through C-37, other generalized factors were developed specifically for use with air-launched missiles. The factors are based on the four and one quarter years data contained in this report. Over this time span, it was determined that the three Weapons Stations were processing missiles in the following proportions:

Weapon Station	Workload	Percent
NWS Yorktown	13,595	50.0%
NWS Concord	5,571	20.5%
NWS Seal Beach	8,002	29.5%
	27,168	

Workloads for the depots and NOS Indianhead for the same time period were 5,658 and 3,770 respectively. Assuming that the future flow of missiles from the Weapon Stations is the same as in the past, except that all missile G&C sections will go to Alameda, there are basically six routes involved in the computation of this factor.

	Pricing Reference
Yorktown to Alameda	Table C-35
Concord to Alameda	Organic Navy
Seal Beach to Alameda	Table C-33
Yorktown to Indianhead	Table C-36
Concord to Indianhead	Table C-28
Seal Beach to Indianhead	Table C-28

It is assumed that organic Navy vehicles will provide the transportation from Concord to Alameda (a distance of 10 miles) and that the rates from Concord to Indianhead are suitable analogs for the Seal Beach to Indianhead route. No charge is made for the former. Costs were computed using the cheapest truckload rate for Class A Explosive Material with Dual Driver Protective Service. The factor is computed as follows:

	Origin	%	$/cwt	TL Min. Weight (thous. of lbs)	Security ($/cwt)	Rate ($/cwt)	Factor ($/cwt)
G&C	NWS Yorktown	50.0	14.73	42	1.30	16.03	8.02
	NWS Concord	20.5	0	--	--		0
	NWS Seal Beach	29.5	0.95	40	0.63	1.58	0.47
							8.49
RM	NWS Yorktown	50.0	1.46	40	0.35	1.82	0.91
	NWS Concord	20.5	10.32	38	1.36	11.68	2.39
	NWS Seal Beach	29.5	10.32	38	1.36	11.68	3.45
							6.75

The two resulting factors expressed on a per pound basis are $0.0849 for a G&C section and $0.0675 for a Rocket Motor. In the former case this is the average cost of a one-way trip from a NWS to NARF Alameda; in the latter, a one-way trip from a NWS to NOS Indianhead.

If the analyst wishes to tie this to the reject ratio of G&C
sections at the NWS, it can be expressed as costing $0.260 per pound
(FY79$) in transportation costs for each G&C failure detected at the NWS.

Factor #1 Derivation

G&C		$0.0849
Rocket Motor	$0.666^1 \times 0.0675$	0.0450
		0.1299
Return Trip		0.1299
Total		$0.260/lb./G&C failure

The second factor is given in order to demonstrate effect on the
rates of shipping in less than truck load (LTL) rates. A situation which
frequently occurs due to the practical pressures of managing the missile
inventory. This factor is calculated in the same manner as the previous one, except
that half of the missile poundage is shipped in dromedary units. All routes
are calculated with Dual Driver Protective Service.

	Origin	%	Rate ($/cwt)	Dromedary Min. Wt. (thous.of lbs)	Security ($/cwt.)	Rate ($/cwt)	Factor ($/cwt)
G&C	NWS Yorktown	50.0	38.63	2,500	21.84	60.47	30.24
	NWS Concord	20.5	—	—	—	—	0
	NWS Seal Beach	29.5	10.80	2,500	10.09	20.89	6.16
							36.40
RM	NWS Yorktown	50.0	12.18	2,500	5.72	17.90	8.95
	NWS Concord	20.5	36.71	2,500	20.65	57.36	11.76
	NWS Seal Beach	29.5	36.71	2,500	20.65	57.36	16.92
							37.63

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[1]0.666 is a ratio of containerized rocket motor weight to containerized G&C
weight of air-launched missiles shipped from IMA's to Depots as shown in budget
back-up material for the period FY76-78.

The preceding calculation refers only to the rates for the poundage shipped
in dromedary units. To complete the computation each factor must be averaged
with the corresponding rate from the truckload computation, i.e., the G&C
rate would be $(0.0849 + 0.3640) \div 2$, or 0.2245 per pound and the RM rate
would be $(0.0675 + 0.3763) \div 2$, or 0.2219 per pound. To complete the example,
the calculations are as follows:

Factor Derivation (2)

G&C		$0.2245
Rocket Motor 0.666 x 0.2219		0.1478
		0.3723
Return Trip		0.3723
	Total	$0.7446/lb/G&C failure

All of the preceding discussion refers to transportation by commer-
cial motor freight. Although that is the way the vast majority of missiles
and missile components are currently transported, it is nevertheless possible to
ship by air. The Navy Material Transportation Office, Norfolk, VA, manages contract
air transportation called QUICKTRANS for the Navy, but there are several reasons
why it is less preferred than surface transportation. First, air transportation
of Class A and Class B explosives cannot be accomplished without a waiver of
Federal Aviation Administration regulations. As a practical matter, this is
seldom worth the effort. Class C material can be air-lifted in restricted
quantities. A second problem is the routing of air transportation. Getting
a shipment to and from a QUICKTRANS location can often completely offset the
time savings of shipping by air. Finally, the cost of shipping by air is also
a barrier. Mrs. Swindeck provided a rate of $42.16 per hundredweight for
QUICKTRANS from Norfolk to the West Coast. This is compared to $10.82 for
a less truckload (LTL) of INERT material from NWS Yorktown to NARF Alameda
(Table C-36 of Appendix C).

Despite this, it has been recently learned that authorization has been given to ship virtually all G&C units from NWS Yorktown to NARF Alameda by air (QUICKTRANS). Therefore, a third factor is computed which is similar to the second one except the G&C rate is computed entirely at the QUICKTRANS rate for the Yorktown to Alameda route. All others are half-TL and half-LTL.

	Origin	%	Rate ($/cwt)	Security ($/cwt)	Rate ($/cwt)	Factor ($/cwt)
G&C	NWS Yorktown	50.0	42.16	-	42.16	21.08
	NWS Concord	20.5	-	-	-	0
	NWS Seal Beach	29.5	5.88	5.36	11.24	3.32
						24.40
Rocket Motor		(Same as Factor #2)				22.19

Factor #3 Derivation

G&C		$0.02440/lb
Rocket Motor	0.666 x 0.2219	0.1478
		0.3918
Return Trip		0.3918
	Total	$0.7836/lb/G&C failure

These factors which are applied to the number of pounds of G&C units (containerized) detected as failures at the NWS and sent to the depot, estimate the cost of transportation associated with those sections. They are, of course, only three of an infinite variety of factor calculations that can be made from the data in this section. The analyst is free to tailor the assumptions to each new situation.

There is, however, another requirement for transporation - the
transhipment of missile and missile sections to meet load-out requirements
and for a number of other reasons. It would be extremely difficult to
obtain data on this type transportation and even more difficult to estimate
future requirements. However, discussions with Mrs. Swindeck (Au8-963-4721)
of the NWS Yorktown Supply Department indicate that the cost of transhipping
missiles is approximately as great as that of shipping sections to the
repair facilities. Accordingly, each of the three previous factors should
be multiplied by a factor to account for transhipment costs. Assuming the
factor 2 is used, the previous factors are modified as follows:

FACTOR	ASSUMPTION	REVISED FACTOR
1	All TL rates	$0.520/lb /G&C failure
2	One-half TL, One-half LTL (Dromedary)	1.4892/lb /G&C failure
3	Yorktown to Alameda, QUICKTRANS All other, same as Factor #2	1.5672/lb /G&C failure

9c. Cost-Estimating Relationship - The analyst can use a generalized factor
or the specific rates in Tables C-28 through C-37 of Appendix C. If the
latter is utilized, then the following information must be obtained
regarding the transportation requirements:

- the number of missile G&C sections
  requiring transportation to the depot and back.

- the number of missile rocket motors requiring transportation
  to the depot.

- the containerized wights of all sections and AUR's to be shipped.

- the number of AUR's requiring shipment to meet loadout requirements.

- the transportation required for other reasons, e.g., shipment to Pacific Missile Test Center (PMTC) Pt. Mugu, CA.

- the quantities, shipment sizes, level of security for all of above.

The analyst can then compute specific shipment costs.

If a generalized factor is sufficiently accurate, the analyst can use one of the three given in this section. The equations are:

$$SDT = WL \times ASW \times 0.5200 \quad \text{(using Factor \#1)}$$

$$SDT = WL \times ASW \times 1.4892 \quad \text{(using Factor \#2)}$$

$$SDT = WL \times ASW \times 1.5672 \quad \text{(using Factor \#3)}$$

where,

SDT = the annual cost of Second Destination Transportation (FY79$K)

WL = the depot workload; ie., the number of G&C sections processed.

ASW = the unit containerized weight of the G&C unit (in thousands of pounds)

(See Exhibit III-5 for containerized weights of missiles currently in the inventory.)

9d.1 Example Calculation 1:

Assume: Generalized Factor #3 is appropriate:

WL = 144 G&C Sections

ASW = 0.228 pounds

SDT = 144 x 0.228 x 1.5672

= 51.5 (FY79$K)

EXHIBIT III-5
WEIGHTS OF AIR-LAUNCHED MISSILES
(pounds)

		Missile/Section Weight	Weight of Container	Units per Container	Unit Containerized Weight
Phoenix	(AGM-54A)				
	AUR	985	580	2	1,275
	Guidance	146	64	1	228
	Control	116	26	1	142
	Propulsion	465	370	1	835
Shrike	(AGM-45A, B)				
	AUR	375	500	3	542
	Guidance	96	41	1	137
	Control	33	33	1	66
	Propulsion	162	140	1	302
Sidewinder	(AIM-9G, H)				
	AUR	190	520	4	1,320
	Guidance & Control	44	67	2	78
	Propulsion	99	30	1	129
Sparrow	(AIM-7E)				
	AUR	500	695	3	2,732
	Guidance & Control	156	135	1	291
	Propulsion	156	124	1	280
Standard ARM	(AGM-78D)				
	AUR	1,370	680	1	2,050
	Guidance	77	150	1	277
	Control	76	68	1	144
	Propulsion	724	268	1	992
Walleye I					
	AUR	1,100	725	2	1,463
	Guidance	102	118	1	220
	Control	119	118	1	237

Metric Conversion: 1 pound = 0.453 kilograms

9d.2 Example Calculation 2: (Using modified Factor #2)

Assume:

IMA Annual Workload = 1,500 missiles

IMA Reject Ratios (G&C) = 0.22

IMA Reject Ratio (RM) = 0.05

G&C Containerized Weight = 0.228 pounds (K)

RM Containerized Weight = 0.900 pounds (K)

WL = 330 (1,500 x 0.22)

Recompute Rocket Motor Factor:

G&C Poundage = 1,500 x 0.22 x 0.228 = 75.24 (K)

RM Poundage = 1,500 x 0.05 x 0.900 = 67.50

RM Factor = 67.50 ÷ 75.24 = 0.897

Factor #2 is revised as follows:

G&C	$0.2245/lb/G&C failure
Rocket Motor 0.897 x 0.2219	0.1990
	0.4235
Return Trip	0.4235
	0.8470
Transhipment Costs	0.8470
	$1.6940/lb/G&C failure

SDT = 330 x .228 x 1.6940

   = 127.5 (FY79$K)

10. RECEIPT, SEGREGATION, STORAGE AND ISSUE (RSSI)

10a. <u>Definition</u> - This is the cost of personnel and material required for
the on-loadings and off-loadings of ships, movement and handling of missiles
to and from storage depots and NWS's, and storage of missiles.

10b. <u>Discussion</u> - The Naval Weapons Support Center, Crane, Indiana, maintains
cognizance over the RSSI program and annually publishes a RSSI, Forecast of
Requirements. The data contained in Table C-38 of Appendix C is from the
Forecast of Requirements dated April 6, 1978. Since the RSSI functions sup-
port many other weapons and/or types of ammunition it is important to identify
the costs incurred specifically for air-launched missiles. The Forecast of
Requirements does identify the cost of receipts and issues for air-launched
missiles, but the cost of on-loading and off-loading must be allocated. The
procedure used to obtain the data in Table C-38 for on-loading and off-loading
was to compute the average cost per ton for AO/AOE's and/or carriers and apply
the cost per ton respectively for on-loading to issue tonnage and the cost per
ton for off-loading to receipt tonnage. Mr. Wimmenauer of NWSC, Crane, (autovon
482-1308),who supplied the data and recommended the allocation procedure, is
the expert on RSSI.

10c. <u>Cost-Estimating Relationship</u> - Although RSSI costs are not identifiable
at this time to a particular type missile, an estimate can be obtained using
the average cost per ton data contained in Table C-38 (Avg. = 0.29 per ton,
FY79$K). The equation is as follows:

$$RSSI = NT \times 0.29$$

$$NT = NWSWL \times WM$$

where,

RSSI = the annual RSSI cost for a particular missile type (FY79$K).

NT = the number of short tons to be handled by the RSSI department.

NWSWL = the annual NWS workload; i.e., the number of missiles of a particular type which undergo NWS maintenance in a year.

WM = the containerized weight per missile (short tons).

10d. Example Calculation

Assume: 4 missile per container, total weight = 0.900 short tons

NWSWL = 1199 missiles

WM = 0.225 short ton

RSSI = 1199 x 0.225 x 0.29

= 78.6 (FY79$K)

Note: 1 short ton = 2,000 pounds = 907 kilograms

11.   REPLACEMENT TRAINING

11a. Definition - This is the variable cost of recruit and technical training including:

- o the pay of personnel in training who will replace missile operations, below-depot maintenance and installation support personnel,

- o the cost of their instruction,

- o the pay of instructor personnel.

11b. Discussion - This cost may be estimated utilizing the factors in the Navy Resource Model (NARM) Program Factors Manual, which were developed by summing all of the costs of the students and two-thirds the cost of staff personnel and operating funds for the program elements shown below and allocating them to weapons systems on the basis of their personnel demands.

81114N	Flight Training
81111N	Recruit Training
81112N	Specialized Training
81113N	Professional Training
24633N	Fleet Support Training
88097N	Administrative Support Training

As with Base Operating Support, the factors used to compute this cost are not explicitly identified in the narrative of the Navy Program Factors Manual, although those factors used in the 31 August 1977 Factors Manual are given in this report. Information on subsequent revisions can be obtained from Ms. Ruth, Op-901 (X-55038).

11c. Cost-Estimating Relationship - The equations are:

$$TO = 0.0001 \ DBE \ + 0.0028 \ DBT \ + 0.0613 \ DBO$$

$$TE = 0.1036 \ DBE \ + 0.0233 \ DBT \ + 0.0067 \ DBO$$

$$TOM = 0.0041 \ DBE + 0.3377 \ DBT$$

$$TRT = (TO \times OPR) + (TE \times EPR) + TOM$$

where,

TO = the number of training officers required to support the weapon system.

DBE = the number of direct en` ̇ d plus base operating enlisted (defined and computed in section III, 5c.) required to support the weapon system.

DBT = the number of total (officer and enlisted) personnel, direct and base operating (defined and computed in Section III, 5c.) required to support the weapon system.

DBO = the number of direct officers plus base operating officers, (defined and computed in Element 5) required to support the weapon system.

TE = the number of training enlisted required to support the weapon system.

TOM = training O&M funds. (FY79$K)

TRT = total replacement training costs. (FY79$K)

OPR = officer pay rate. (FY79$K = 22.141)

EPR = enlisted pay rate. (FY79$K = 9.517)

11d. **Example Calculation**

Assume:

$$DBE = 6.0$$

$$DBT = 6.0$$

$$DBO = 0$$

$$TO = 0.0001(6.0) + 0.0028(6.0) + 0.0613(0)$$

$$= 0.02 = 0.0 \ \text{officers}$$

$$TE = 0.1036(6.0) + 0.0233(6.0) + 0.0067(0)$$

$$= 0.7 \ \text{enli} \cdot$$

$$TOM = 0.0041(6.0) + 0.3377(6.0)$$

$$= 2.1 \ O\&M \ \text{funds} \ (FY79\$K)$$

$$TRT = (0 \times 22.1) + (0.7 \times 9.5) + 2.1$$

$$= 8.8 \ (FY79\$K)$$

12. HEALTH CARE

12a. <u>Definition</u> - Health Care is the cost of providing medical support to
missile operations, below-depot maintenance and base operating support
and training pipeline personnel including:

     o   the pay of medical personnel who provide this support,

     o   the cost of medical material.

12b. <u>Discussion</u> - The NARM estimates this cost by summing two-thirds (2/3) of
the cost of medical operations and adding the pay of patients. The program
elements are:

```
81211N      Hospitals
81212N      Medical Centers
81216N      Other Medical Activities
81213N      Patients
```

As with Base Operating Support and Replacement Training, the factors used to
compute this cost are not explicitly identified in the narative of the Factors
Manual. Those factors used in the most recent edition, 31 August 1977, are
given in this report and subsequent revisions can be obtained from Ms. Ruth,
Op-901 (X-55038).

12c. <u>Cost-Estimating Relationship</u> - The equations are:

$$HO = 0.0092\ DET$$

$$HE = 0.0182\ DBT$$

$$HOM = 0.4148\ DBT$$

$$HT = (HO \times OPR) + (HE \times EPR) + HOM$$

where,

     HO = the number of health care officers necessary to support the
weapon system.

DET $=$ the total number of personnel, officers and enlisted, direct plus base operating required to operate and provide base support to the missile system (from Section III, 5c.)

HE $=$ the number of health care enlisted necessary to support the weapon system.

HOM $=$ the health care O&M funds necessary to support the weapon system.

HT $=$ the total cost of health care necessary to support the weapon system. (FY79$K)

OPR $=$ officer pay rate (FY79$K $=$ 22.141)

EPR $=$ enlisted pay rate (FY79$K $=$ 9.517)

12d. <u>Example Calculation</u>

Assume: DBT $=$ 6.0 (from Element 5, Section III, 5d.)

HO $=$ 0.0092(6.0)

$=$ 0.1 officer

HE $=$ 0.0182(6.0)

$=$ 0.1 enlisted

HOM $=$ 0.4148(6)

$=$ 2.5 O&M (FY79$K)

HT $=$ (0.1 x 22.1) + (0.1 x 9.5) + 2.5

$=$ 5.7 (FY79$K)

13. PERSONNEL SUPPORT

13a. <u>Definition</u> - Personnel Support is comprised of two parts. The first part consists of the costs incident to the Permanent Change of Station (PCS) of missile operation and below-depot maintenance personnel, either individually or as an organized unit, and base operating support personnel. PCS is the cost of duty station rotation for all squadron and supporting personnel. The second portion is the cost of recruiting and examining activities and the cost of transient personnel and prisoners.

13b. <u>Discussion</u> - PCS rates are figured in the <u>Navy Resource Model</u> by dividing the total PCS cost by the number of personnel, producing an annual PCS cost per person (officers/enlisted). This is applied to the number of personnel operating and supporting the missile system to obtain an estimate. The other costs, recruiting and examining, transients and prisoners, are estimated by the NARM by summing two-thirds (2/3) of the cost of recruiting and examining activities and all of the costs associated with transients and prisoners; and allocating these costs to the weapon system on the basis of the number of personnel. The program elements are given below:

```
81412N      Recruiting and Examining
81411N      Prisoners
81415N      Transients
```

13c. <u>Cost-Estimating Relationship</u> - The equations for estimating Personnel Support are:

$$PCS = 1.4515 \text{ DBO} + 0.4615 \text{ DBE}$$

$$REOM = 0.0889 \text{ DBE}$$

$$REO = 0.0009 \text{ DBE}$$

$$REE = 0.1036 \text{ DBE}$$

$$PE = 0.0119 \ DBE$$

$$TOT = 0.0584 \ DBT$$

$$TET = 0.0433 \ DBE$$

$$TPA = REOM + (REO + TOT) \times OPR + (REE + PE + TET) \times EPR + PCS$$

where,

PCS = the annual cost (MPN funds) of PCS for weapon system direct and base operating personnel. (FY79$K)

DBO = the total number of officer personnel, direct plus base operating, required to operate and provide base support to the missile system (from Section III, 5c.)

DBE = the total number of enlisted personnel, direct plus base operating, required to operate and provide base support to the missile system (from Section III, 5c.)

REOM = recruiting and examining O&M funds. (FY79$K)

REO = the number of recruiting and examining officers necessary to support the weapon system.

REE = the number of recruiting and examining enlisted necessary to support the weapon system.

PE = the number of enlisted prisoners.

TOT = the number of officers in transit.

DBT = the total number of personnel, officers and enlisted, direct plus base operating, required to operate and provide base support to the missile system (from Section III, 5c.)

TET = the number of enlisted personnel in transit.

TPA = the total cost of Personnel Support. (FY79$K)

OPR = officer pay rate. (FY79$K = 22.141)

EPR = enlisted pay rate. (FY79$K = 9.517)

13d. Example Calculation

Assume:

DBO = 0.0 officers

$$\text{DBE} = 6.0 \quad \text{enlisted}$$

$$\text{DBT} = 6.0 \quad \text{total personnel}$$

$$\text{PCS} = 1.4515(0) + 0.4615(6.0)$$

$$= 2.8 \text{ MPN funds (FY79\$K)}$$

$$\text{REOM} = 0.0889(6.0)$$

$$= 0.5 \text{ O\&M funds (FY79\$K)}$$

$$\text{REO} = 0.0009(6.0)$$

$$= 0.0 \quad \text{officers}$$

$$\text{REE} = 0.1036(6.0)$$

$$= 0.6 \quad \text{enlisted}$$

$$\text{PE} = 0.0119(6.0)$$

$$= 0.1 \quad \text{enlisted}$$

$$\text{TOT} = 0.0584(6.0)$$

$$= 0.4 \quad \text{officers}$$

$$\text{TET} = 0.0433(6.0)$$

$$= 0.3 \quad \text{enlisted}$$

$$\text{TPA} = 0.5 + (0.0 + 0.4) \times 22.1 + (0.6 + 0.1 + 0.3) \times 9.5 + 2.8$$

$$= 21.6 \text{ (FY79\$K)}$$

14. REPLENISHMENT SPARES

14a. Definition - This is the cost of procuring missile spares and repair
parts which are normally repaired and returned to stock. In addition, this
cost can include procurement of stock levels that are not provided by initial
spares procurement. Repairable items are identifiable by the Aviation Supply
Office (ASO) cognizance (COG) codes 6E (air-launched missile, non-explosive
components) and 4E (air-launched missile, explosive components).

14b. Discussion - The requirements for 6E COG items are determined by the
Inventory Control Point (ICP) which is the Ships Parts Control Center (SPCC),
Mechanicsburg, Pennsylvania, through line-item stratification.* Usage rates,
demand/issue data, carcass-return-rates, procurement lead times, and other
factors are incorporated into the analysis to estimate the annual requirements
for each Nationally Stock Numbered (NSN) item. 4E COG items are handled in
similar fashion but tend to be heavily dependent on age-of-component consider-
ations as opposed to observed failures.

Data for Replenishment Spares was obtained from Ms. Savage (X-20239)
of NAVAIR 4123 and are shown in Tables C-39 and C-40 of Appendix C. The reader
is cautioned that Replenishment Spares costs are extremely changeable and can
vary significantly from missile to missile and from year to year depending on
variation in the factors mentioned in the preceding paragraph. As an example,
the following table presents two estimates of the costs of 6E COG Replenishment
Spares for the fiscal year 1980. The first column presents the costs as they
were estimated in support of the 1979 Program Objective Memorandum (POM 79);
and the second, as they were estimated for POM 80.

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*For more information on this process, refer to DOD Instruction 4140.24.

6E COG Replenishment Spares for FY80

Missile	POM79 (FY79$K)	POM80 (FY79$K)
Sidewinder	730	1,423
Sparrow	774	384
Shrike	59	604
Standard Arm	171	402
Phoenix	455	203
Harpoon	703	77

14c. **Cost-Estimating Relationship** - Keeping in mind the changeability of these costs, one can estimate the annual cost of Replenishment Spares with the following equation:

$$RS = 151.912 + 55.220PI$$
$$(5.53)$$

$$\bar{R}^2 = 0.86$$

$$S.E.E. = 242.871$$

$$Det.of\ X'X = 1.000$$

$$F = 30.624$$

where,

RS = the annual cost of Replenishment Spares (4E COG and 6E COG) for a particular type missile. (FY79$K)

PI = the percent of the missile inventory comprised by the particular missile.

DATA BASE

Missile	RS (FY82) (FY79$K)	PI[1] % (FY82)
Sidewinder	1,401	23.0
Sparrow	2,034	33.1
Standard Arm	163	3.9
Phoenix	769	16.4
Harpoon	1,073	13.1
HARM	756	6.2

[1]The variable PI has been adjusted from the values shown in Exhibit IV-1 to reflect only those missiles that have Replenishment Spares funding.

14d. <u>Example Calculation</u>

Assume:

PI = 18.5 (avg. of life cycle)

RS = 151.912 + 55.220(18.5)

= 1173.5 (FY79$K)

15. MODIFICATIONS

15a. <u>Definition</u> - This is the cost of modifying missiles, missile support equipment, and training equipment that are in the operating inventory to make them safe for continued operations, to enable them to perform their missions and to improve reliability to reduce maintenance cost. This includes labor, modification kits, and consumable material.

15b. <u>Discussion</u> - Data for the cost of procuring modification kits or material was obtained from the WPN Budget and are shown in Table C-41 of Appendix C. Generally the procurement of Modifications is funded with WPN by the specific program office responsible for the missile and depends on a myriad of factors such as threat considerations, maintainability, safety, etc. Installation of Modifications,which is funded by O&MN and takes place at the depots and sometimes the NWS's, is dependent on the amount and kind of modification material that has been procured and is available for installation. Installation data from the FY78 and FY79 budget submissions is contained in Table C-42.

15c. <u>Cost-Estimating Relationship</u> - For some missile programs, the planned modifications kits or components may be specified in sufficient detail so that unit procurement and installation costs can be estimated using conventional procurement estimating methodology. In these cases, the analytical representation of the cost of Modifications would be:

$$M = NMK \times CMK + NMI \times CI$$

where,

M = the annual cost of Modifications for an air-launched missile type. (FY79$K)

NMK = the annual number of modification kits to be procured.

CMK = the unit cost of a modification kit. (FY79$K)

NMI = the annual number of modification kits to be installed.

CI = the unit cost of installing a modification kit. (FY79$K)

For most missile programs still in development, there are no planned modifications and the analyst is forced to make an estimate with no supporting program information. Data from Tables C-41 and C-42 for the years FY78 and FY79 are summarized below to serve as guidelines or possible analogs.

Modification Costs (FY79$K)

	FY78			FY79		
	Proc.	Install	Total	Proc.	Install	Total
Sidewinder	0	5	5	300	10	310
Sparrow	750	659	1,409	1,725	626	2,351
Walleye I	0	0	0	0	0	0
Walleye II	0	0	0	0	0	0
Shrike	0	0	0	700	0	700
Standard Arm	0	15	15	0	15	15
Phoenix	2,170	169	2,339	5,214	169	5,383
Harpoon	0	0	0	0	0	0
Harm	0	0	0	0	0	0

15d. Example Calculation

Assume example missile has Modifications costs comparable to the FY79 Sidewinder experience.

$$M = 310 \ (FY79\$K)$$

16. REPLENISHMENT GROUND SUPPORT EQUIPMENT (RGSE)

16a. Definition - Replenishment Ground Support Equipment (RGSE) is the cost of procuring missile ground servicing equipment, maintenance and repair shop equipment, instruments and laboratory test equipment, and other equipment items. These equipment demands are generated by a need to: (1) replace peculiar support equipment bought using procurement funds; (2) obtain common off-the-shelf ground equipment that are needed to support missile operations; and (3) replenish common ground equipment that is no longer useable.

16b. Discussion - These items are funded by the program office but unfortunately it is sometimes impossible to distinguish replacement items from initial items, therefore no data is currently available. Discussions with NAVAIR personnel indicate that RGSE costs for air-launched missiles are small. Items bought to be used in handling at the organizational level are relatively inexpensive and the expensive test sets at the NWS's and depots are seldom replaced entirely.

16c. Cost-Estimating Relationship - One method of estimating this cost is given below. It was developed from an OSD analysis of RGSE for all types of weapon systems.

$$RGSE = 0.0025 \times WL \times CAC_{1000}$$

where,

$RGSE$ = the annual cost of Replenishment Ground Support Equipment. (FY79$K)

WL = the annual depot workload (computed in Element 6, Sec.III, 6c.)

CAC_{1000} = the cumulative average hardware cost of the first one thousand missiles procured. (FY79$K)

16d. Example Calculation:

Assume:

WL $=$ 144   (from Element 6)

CAC_{1000} $=$ 145   (from Element 6)

RGSE $=$ 0.0025 x 144 x 145

$=$ 52.2 (FY79$K)

IV.   DATA BASE

This section contains the data which were used in the cost-estimating relationship (CER) development including all independent or explanatory variables. The compilation of these data will enable the reader to continue CER development as new data become available in the future. It is important to point out some of the classical problems of CER development which were encountered in this study and will undoubtedly be encountered in future missile CER development.

The initial problem is the small data base, having at most eight observations. "No degree of sophistication in the use of advanced mathematical statistics can compensate very much for a seriously deficient data base."* Although this data base is not "seriously deficient," it does limit the flexibility of the analysts to make corrections for other data problems and still perform extensive statistical analyses. The other data problems which are also discussed by Fisher in the cited reference are temporal and comparability problems. The former is a group of problems that arise because information is collected over time; the first of which, adjusting for price level changes, is not too difficult to handle. OSD indices which are given in Section III were used to adjust all costs to FY79 dollars. A second temporal problem is the fact that formats and reporting requirements have changed over time, thus making it difficult or impossible to obtain each desired datum for every time period. This results in CER's which are based on data from slightly different time spans. This brings us to the third temporal problem, that of the quickly

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*Fisher, Gene H., Cost Considerations in Systems Analysis, American Elsevier Publishing Co., Inc., New York, 1971, p. 123.

changing environment, both in hardware and in organizational and operational concepts. This makes it important to collect as many observations as possible which reflect the same environment, or to explicitly present environmental factors as dependent variables. Both are difficult to do with the small population of air-launched missile types.

The second gr up of problems is concerned with comparability and there are many comparability considerations to be made for this data base. The most obvious one is the case of the Walleye I and II, which are unpowered weapons. This is the reason that a CER was included in the Depot Maintenance section which estimates only G&C repair cost. The Harpoon missile also presents a comparability problem since it contains a small jet engine rather than a rocket motor; the Sidewinder missile is another, since under the current maintenance philosophy none of the G&C components are repairable. Standard Arm is yet another, because the small number in the inventory results in an unusually high unit cost. There are other comparability problems as well — some maintenance is done commercially rather than within the Navy; and some missile systems are just entering the inventory while others are being phased out.

The purpose of mentioning these problems is to alert the user to their presence and the fact these problems might result in a CER of a form which is contrary to a rational causal relationship (e.g., a negative intercept or slope). Analytical corrections of observations is very subjective and would require extensive research, and to remove the questionable observation is disadvantageous because of the small size of the data base. For the statistical

CER's contained in this report, an examination of the residuals was made to determine any obvious signs of temporal or comparability problems. Generally, ad hoc adjustments would not have improved the CER's but, again, the user is alerted to make these considerations when future data is analyzed.

The data used for CER development is contained in Exhibits IV-1 and IV-2. The latter contains Replenishment Spares data and the associated explanatory variables which were investigated; while the former contains NWS, Depot, Quality Evaluation, Fleet Support, and Engineering Support costs and explanatory variables. Exhibits IV-3 and IV-4 contain the correlation matrices for the data in Exhibits IV-1 and IV-2 respectively, and Exhibit IV-5 contains a definition for eac variable in Exhibits IV-1 and IV-2.

EXHIBIT IV-1

DATA BASE FOR COST-ESTIMATING RELATIONSHIPS

Missile	1 DUC (FY79$K)	2 NWS (FY79$K)	3 IRR	4 D (m.)	5 L (m.)	6 LW (kg)	7 LWO (kg)	8 LWOP (kg)
Sidewinder	3.59	1.069	0.13	0.128	2.90	85	77	32
Sparrow (AIR)	3.97	1.837	0.30	0.204	3.66	227	200	129
Walleye I	2.19	1.154	0.07	0.381	3.44	510	225	225
Walleye II	2.85	1.343	0.09	0.457	4.04	1,089	182	182
Shrike	1.12	1.358	0.22	0.204	3.05	181	137	63
Standard Arm	15.35	3.483	0.30	0.335	4.54	615	548	220
Phoenix	6.90	1.765	0.24	0.381	3.96	447	421	211
Harpoon	5.94	2.669	0.19	0.335	3.81	530	375	322

Missile	9 79QE (FY79$K)	10 QE (FY79$K)	11 FS (FY79$K)	12 ES4 (FY79$K)	13 ES5 (FY79$K)	14 ES (FY79$K)	15 DDG (FY79$K)	16 VS (Mach)
Sidewinder	480	465	271	742	689	1 431	2.1	4.0
Sparrow (AIR)	399	397	271	853	358	1 241	3.1	2.5
Walleye I	142	176	117	276	71	347	1.8	1.0
Walleye II	71	88	52	145	36	181	2.5	1.0
Shrike	337	324	192	439	218	657	1.3	2.0
Standard Arm	119	90	107	433	276	709	9.4	2.0
Phoenix	390	268	170	509	238	747	8.7	5.0
Harpoon	315	262	98	703	154	857	4.1	0.8

Note: See Exhibit IV-5 for definitions.

EXHIBIT IV-1 (cont'd.)

DATA BASE FOR COST-ESTIMATING RELATIONSHIPS

Missile	17 PI79 %	18 CAC_{1000} (FY79$K)	19 AAD
Sidewinder	14.30	35.4	1
Sparrow (AIR)	14.10	129.6	1
Walleye I	18.30	47.3	0
Walleye II	2.90	56.1	0
Shrike	20.60	48.7	0
Standard Arm	2.00	222.0	0
Phoenix	5.90	335.2	1
Harpoon	3.10	340.9	0

Note: See Exhibit IV-5 for definitions.

EXHIBIT IV-2

DATA BASE FOR REPLENISHMENT SPARES COST-ESTIMATING RELATIONSHIPS

Missile	20 RS79 (FY79$M)	21 RS80 (FY79$M)	22 RS84 (FY79$M)	23 PI79 %	24 DUC (FY79$K)	25 CAC$_{1000}$ (FY79$K)	26 AAD	27 LWO (kg)
Sidewinder	2.60	3.17	2.87	14.3	3.54	35.4	1	77
Sparrow (AIR)	0.77	0.59	0.56	14.1	3.97	129.6	1	200
Shrike	0.72	0.83	0.76	20.6	1.12	48.7	0	137
Standard Arm	0.27	0.41	0.38	2.0	15.35	222.0	0	548
Phoenix	0.10	0.20	0.33	5.9	6.90	335.2	1	421
Harpoon	0.20	0.31	0.38	3.0	5.94	340.9	0	375
Harm	0.00	0.00	0.28	0.0	4.64	105.0	0	284

Missile	28 PI80 %	29 PI %	30 RS82 (FY79$K)	31 NWSWL (thous.msl.)	32 80RS (FY79$K)	33 RS (FY79$K)	34 IV80 (FY79$M)	35 IN82 (FY79$M)
Sidewinder	12.4	10.7	2,880	1.63	1,395	1,401		
Sparrow (AIR)	15.8	15.4	606	1.43	833	2,034		
Shrike	18.5	17.9	702	0.96	285	276		
Standard Arm	1.8	1.8	391	0.08	163	163		
Phoenix	6.1	7.6	246	0.97	428	769		
Harpoon	4.0	6.1	588	0.00	893	1,073		
Harm	0.1	2.9	102	0.00	0	756		

Note: See Exhibit IV-5 for definitions.

EXHIBIT IV-3

CORRELATION MATRIX FOR DATA IN EXHIBIT IV-1

	1	2	3	4	5	6	7	8	9	11
1	1.000									
2	.992	1.000								
3	.583	.650	1.000							
4	.196	.191	-.296	1.000						
5	.768	.756	.379	.689	1.000					
6	.201	.210	-.325	.899	.693	1.000				
7	.877	.868	.521	.482	.842	.328	1.000			
8	.404	.575	.004	.735	.678	.570	.717	1.000		
9	-.256	-.256	.298	-.766	-.597	-.341	-.321	-.470	1.000	
10	-.421	-.404	.161	-.872	-.755	-.878	-.551	-.612	.949	1.000
11	-.247	-.331	.339	-.887	-.617	-.888	-.458	-.720	.856	.919
12	.055	.162	.516	-.730	-.286	-.724	-.066	-.190	.827	.806
13	.078	-.103	.232	-.836	-.456	-.722	-.286	-.649	.737	.767
14	.071	.042	.420	-.845	-.396	-.787	-.180	-.433	.854	.856
15	.385	.734	.596	.334	.770	.201	.912	.442	-.112	-.371
16	.118	-.176	.317	-.367	-.174	-.499	.022	-.429	.682	.525
17	-.663	-.660	-.184	-.585	-.833	-.676	-.691	-.633	.363	.552
18	.569	.674	.497	.317	.576	.117	.804	.705	.131	-.147
19	-.077	-.274	.287	-.483	-.259	-.543	-.196	-.429	.776	.715

	11	12	13	14	15	16	17	18	19
11	1.000								
12	.754	1.000							
13	.818	.696	1.000						
14	.850	.934	.906	1.000					
15	-.215	.019	-.013	.005	1.000				
16	.622	.389	.643	.549	.393	1.000			
17	.585	.125	.234	.191	-.670	.064	1.000		
18	-.236	.286	-.158	.091	.746	.202	-.655	1.000	
19	.793	.648	.701	.729	.133	.346	.141	.094	1.000

EXHIBIT IV-4

CORRELATION MATRIX FOR DATA IN EXHIBIT IV-2

	20	21	22	23	24	25	26	27	28	29
20	1.000									
21	.991	1.000								
22	.983	.996	1.000							
23	.396	.370	.293	1.000						
24	-.346	-.292	-.317	.151	1.000					
25	-.609	-.560	-.564	-.439	.494	1.000				
26	.509	.460	.462	.035	-.230	-.052	1.000			
27	-.708	-.649	-.660	-.171	.974	.787	-.330	1.000		
28	.529	.449	.402	.599	-.645	-.545	.397	-.748	1.000	
29	.409	.326	.285	.479	-.727	-.487	.356	-.745	.983	1.000
30	.992	1.000	.997	.351	-.306	-.563	.470	-.660	.447	.326
31	.737	.673	.653	.413	-.506	-.467	.833	-.694	.805	.747
32	.781	.762	.750	.064	-.325	-.105	.599	-.504	.411	.347
33	.409	.314	.321	-.206	-.412	-.119	.686	-.468	.346	.355
34	-.193	-.253	-.285	-.055	-.159	.499	.555	.074	.361	.428
35	-.346	-.377	-.392	-.313	-.117	.696	.405	.214	.121	.217

	30	31	32	33	34	35
30	1.000					
31	.678	1.000				
32	.767	.621	1.000			
33	.332	.564	.703	1.000		
34	-.249	.336	.252	.461	1.000	
35	-.372	.148	.199	.373	.947	1.000

EXHIBIT IV-5

DEFINITIONS OF DATA ELEMENTS IN EXHIBITS IV-1 and IV-2

Number	Abbr.	Definition
1	DUC	the total depot unit cost for a particular type missile (FY79$K)
2	NWS	the unit cost of NWS maintenance (FY79$K)
3	IRR	the intermediate reject ratio, i.e., the percentage of missiles processed by the NWS which are determined to be failures and are sent to the depot for repair.
4	D	the missile diameter (meters)
5	L	the length of the missile (meters)
6	LW	the launch weight of the missile (kilograms)
7	LWO	the launch weight of the missile less the ordnance weight (kilograms)
8	LWOP	the launch weight of the missile less the ordnance and propulsion weights (kilograms)
9	79QE	the annual cost of Quality Evaluation for FY79 (FY79$K)
10	QE	the average annual cost (FY77-79) of Quality Evaluation (FY79$K)
11	FS	the average cost (FY76-79) of Fleet Support (FY79$K)
12	ES4	the average cost (FY76-79) of Engineering Support funded by NAVAIR 4104 (FY79$K)
13	ES5	the average cost (FY76-79) of Engineering Support funded by NAVAIR 510) (FY79$K)
14	ES	the average cost (FY76-79) of total Engineering Support - the sum of 13 and 14 (FY79$K)
15	DGC	the depot unit cost of rework of a missile G&C section. (This does not include repair of G&C repairables.) (FY79$K)
16	MS	the maximum speed of the missile during free flight (Mach)
17	PI79	the percentage of the inventory represented by each missile in FY79
18	CAC_{1000}	the cumulative average cost of the first one thousand missiles procured (FY79$K)
19	AAD	a dummy variable which is equal to 1 for air-to-air missiles, and 0 for air-to-ground missiles
20	RS79	the annual cost of Replenishment Spares in FY79 as shown in POM 80 (FY79$M)

EXHIBIT IV-5 (cont'd.)

Number	Abbr.	Definition
21	RS80	the annual cost of Replenishment Spares in FY80 as shown in POM80 (FY79$M)
22	RS84	the annual cost of Replenishment Spares in FY84 as shown in POM80 (FY79$M)
23	PI79	the percentage of the inventory represented by each missile in FY79
24	DUC	the total depot unit cost for a particular type missile (FY79$K)
25	CAC_{1000}	the cumulative average cost of the first one thousand missiles procured (FY79$K)
26	AAD	a dummy variable which is equal to 1 for air-to-air missiles, and 0 for air-to-ground missiles
27	LWO	the launch weight of the missile less the ordnance weight (kilograms)
28	PI80	the percentage of the inventory represented by each missile in FY80
29	PI	the percentage of the missile inventory represented by each missile in FY82
30	RS82	the annual cost of Replenishment Spares in FY82 as shown in POM80 (FY79$K)
31	NWSWL	the annual NWS workload based on FY79 (thousands of missiles)
32	80RS	the annual cost of Replenishment Spares in FY80 as shown in POM79 (FY79$K)
33	RS	the annual cost of Replenishment Spares in FY82 as shown in POM79 (FY79$K)
34	IV80	the inventory value of each missile based on FY80 inventory (FY79$M)
35	IV82	the inventory value of each missile based on FY82 inventory (FY79$M)

APPENDIX A

CAIG GUIDANCE ON AIR-LAUNCHED
MISSILE O&S COST ELEMENT STRUCTURE

August 31, 1977

MEMORANDUM FOR THE COST ANALYSIS IMPROVEMENT GROUP (CAIG) AND
VAMOSC TASK FORCE

SUBJECT: Weapon System Operating and Support Cost Element Structures
and Definitions

As you know, we have been working with the Services and the OSD
staff for some time to develop CAIG operating and support costing
structures for selected weapon classes.

Enclosed are aircraft, ship, combat vehicle and air-launched
tactical missile cost element structures and definitions. The aircraft
structure represents a modification to the structure contained in the
May 1974 CAIG O&S cost development guide for aircraft systems. The
ship, combat vehicle and tactical missile structures have not been
previously issued.

Effective immediately, these new structures will be used when
preparing and submitting O&S cost estimates of these weapon classes to
the CAIG/DSARC and as the basis for collecting O&S cost data under DOD's
VAMOSC Task.

Our current schedule calls for issuing a revised CAIG aircraft
guide this fall; ship, combat vehicle and missile guides will follow
early next year. These new guides will contain the enclosed cost
structures and incorporate many of the analysis provisions and reporting
formats contained in the "Guidelines for Analysis" developed for the
CAIG by the Logistics Management Institute (LMI). Particular attention
should be paid to: the System Program Definition Statement; the require-
ment for a pre-CAIG meeting to determine the groundrules for the O&S
cost analysis to be conducted for the DSARC/CAIG; and the maintenance
sizing methodology.

I recommend a thorough review of the LMI guidelines now as a
preview of forthcoming CAIG/DSARC and OSD weapon systems analysis
requirements. If you have not received copies of the LMI reports,
please contact Frank Swofford at extension 52612.

Finally, I ask that Service CAIG representatives distribute the new cost structures to their respective system command and program manager organizations. It is important to obtain future PM cost estimates in a form consistent with those prepared by the independent cost teams.

Milton A. Margolis
Chairman
OSD Cost Analysis Improvement Group

Enclosures (4)

AIR-LAUNCHED MISSILE OPERATING AND SUPPORT
COST ELEMENT STRUCTURE

301 Operations
    301.1   Operational Training
    301.2   Handling and Inspection
    301.3   Personnel Support

302 Below Depot Maintenance
    302.1   Missile Maintenance Manpower
    302.2   Munition Maintenance Manpower
    302.3   Maintenance·Materiel
    302.4   Personnel Support

303 Installations Support
    303.1   Base Operating Support
    303.2   Real Property Maintenance.
    303.3   Personnel Support

304 Depot Maintenance
    304.1   Manpower
    304.2   Materiel

305 Depot Supply Support
    305.1   Equipment Distribution
    305.2   Equipment Management
    305.3   Technical Support

306 Second Destination Transportation

307 Personnel Support and Training
    307.1   Individual Training
    307.2   Health Care
    307.3   Personnel Activities
    307.4   Personnel Support

308 Sustaining Investments
    308.1   Replenishment Spares
    308.2   Modifications
    308.3   Replenishment Ground Support Equipments

AIR-LAUNCHED MISSILE OPERATING AND SUPPORT
COST ELEMENT DEFINITIONS

300 **OPERATING AND SUPPORT:** The variable cost of supporting the air-launched missile operation of a deployed aircraft unit. 1/

301 **OPERATIONS**

301.1 **Operational Training:** The cost of: a) operational firings including such costs as range operation, instrumentation, drone and recovery costs; b) captive flight training planing, scheduling and evaluation costs.

301.2 **Handling and Inspection:** The cost of manpower and consumable materiel needed to conduct missile launch and recovery operations in the deployed unit. Included are such tasks as: Removing missiles from storage; missile inspection; missile assembly; transporting missiles to the aircraft; missile uploading; and missile check out and arming prior to a captive flight or firing. This cost also includes a similar series of tasks to download the missile and return it to storage if not fired.

301.2.1 **Manpower:** The pay and allowances of missile handling and inspection personnel.

301.2.2 **Materiel:** The cost of materiel consumed in the missile handling and inspection operation. Excludes the cost of reparable spares which are included in cost element 308.1, Replenishment spares.

301.3 **Personnel Support:** The cost of supplies, services, and equipment needed for support of missile handling and inspection personnel. Included are administrative supply items; expendable office machines and equipment; custodial services; and personnel-oriented support items such as desks and chairs.

302 **BELOW DEPOT MAINTENANCE**

302.1 **Missile Maintenance Manpower**

302.1.1 **Organizational/AIMD:** The cost of paying the personnel needed for maintenance of aircraft missile release systems; missile and missile components; and missile support equipment of the deployed aircraft unit. Included are the costs of supervisory personnel needed for such functions as missile-related maintenance supervision and control; missile quality control; and missile maintenance analyses.

302.1.2 Intermediate Maintenance: The cost of paying the personnel needed for missile and missile component checkout and repair at Naval Weapon Stations and Mobile Missile Maintenance units.

302.2 Munitions Maintenance Manpower: The cost of paying the personnel needed for handling and maintenance of missile warheads. Included are the costs of personnel needed to supervise warhead maintenance, storage and disposal.

302.3 Maintenance Materiel: The cost of purchasing material from the General and System Support Divisions of the stock funds. This cost includes all non-reparable expense items consumed in the missile and warhead repair process. Excludes reparable spares costs which are included in cost element 308.1 (Replenishment Spares).

302.4 Personnel Support: The cost of supplies, services and equipment needed to support below-depot maintenance personnel. Examples of included costs are administrative supply items; travel expenses; expendable office machines and equipment; custodial services; and other variable personnel-oriented support costs incurred at the maintenance activities.

303 INSTALLATIONS SUPPORT

303.1 Base Operating Support: The cost of installation personnel necessary to directly support missile handling and inspection and below-depot maintenance personnel. Examples of installation functions which directly support the unit include food services, custodial services, supply, motor pool, payroll, ADP and communication operations.

303.2 Real Property Maintenance: The variable cost of construction, maintenance and operation of real property facilities and related management, engineering and support work including contracted services that support the missile handling, inspection, maintenance and storage functions.

303.3 Personnel Support: The cost of supplies and equipment needed to support installation support personnel. Examples of included costs are administrative supply items and expendable office machines and equipment.

304 DEPOT MAINTENANCE: The cost of manpower and materiel needed to perform missile and missile component and support equipment maintenance at DoD centralized repair depots and contractor repair facilities.

304.1 Manpower: The cost of paying the personnel needed to perform major overhaul; repair; modification; calibration; inspection; and storage and disposal of missile and missile components and support equipment. Includes a pro rata

share of variable depot facility overhead costs.

304.2 Materiel: The cost of materiel consumed in the depot overhaul, repair, inspection and storage and disposal process.

305 DEPOT SUPPLY: The cost of manpower and materiel needed to buy, store, package, manage and control the supplies, spares and repair parts used in operating and maintaining misssiles and missile components and support equipment; and to provide sustaining (service) engineering and technical data support for missile systems.

305.1 Equipment Distribution: The cost of manpower and materiel needed to fill requisitions for missile and missile support equipment supplies, spares and repair parts. Included are receiving, unpacking, storage, inspection, packing and crating and issuing costs.

305.2 Equipment Management: The cost of manpower and materiel needed to manage the procurement of missile and missile support equipment supplies, spares and repair parts and maintain control and accountability of these assets.

305.3 Technical Support: The cost of sustaining (service) engineering and technical data and documents needed to perform sustaining engineering and maintenance on missile and missile component and support equipment.

306 SECOND DESTINATION TRANSPORTATION: The round trip cost of transporting missiles, missile support equipment and reparable secondary items to the depot maintenance facilities and back to the operational unit, Naval Weapons stations or Service stock points; and the one-way cost of transporting repair parts from Service stock points to depot and below depot maintenance and supply activities.

307 PERSONNEL SUPPORT AND TRAINING: The variable cost of training, moving and providing health care for personnel needed to replace missile handling, inspection, below-depot maintenance and installation support personnel.

307.1 Individual Training: 2/ The variable cost of recruit and technical (skill) training including:

o the pay of personnel in training who will replace missile handling and inspection, below-depot maintenance and installation support personnel

o the cost of their instruction

o the pay of instructor personnel

307.2 Health Care: The variable cost of providing medical support to: missile handling and inspection, below-depot maintenance, installation personnel and training

pipeline personnel including:

o the pay of medical personnel who provide this support

o the cost of medical materiel

307.3 Personnel Activities: The costs incident to the PCS of: missile handling and inspection and below-depot maintenance personnel either individually or as an organized unit; installation personnel; and training pipeline personnel.

307.4 Personnel Support: The cost of supplies, services and equipment needed to support instructor, trainee and medical personnel. Examples of these costs are administrative supply, expendable office equipment and machines, and custodial services.

308 SUSTAINING INVESTMENTS: The cost of procuring spares, modification kits and materiel and ground support equipment for missile support.

308.1 Replenishment Spares: The cost of procuring missile spares and repair parts which are normally repaired and returned to stock. In addition, this cost can include procurement of stock levels that are not provided by initial spares procurement.

308.2 Modification Kits and Materiel: The cost of modifying missiles, missile support equipment, and training equipment that are in the operating inventory to make them safe for continued operation, to enable them to perform their missions and to improve reliability or reduce maintenance cost. Includes spares.

308.3 Replenishment Ground Support Equipment: The cost of procuring missile ground servicing equipment, maintenance and repair shop equipment, instruments and laboratory test equipment, and other equipment items including spares. Covers such items as ground generators and test sets for missile checkout. These equipment demands are generated by a need to: (1) replace peculiar support equipment bought using procurement funds; (2) obtain common off-the-shelf ground equipment that are needed to support missile operations as production aircraft arrive in the operating inventory; and (3) replenish common ground equipment that is no longer useable.

NOTES:

1/ A deployed aircraft unit consists of any unit operating in the field
for combat, training or other operating purpose. To determine the O&S
cost of the air-launched tactical missile under consideration, a typical
deployed aircraft unit operation will be assumed. The O&S estimate will
reflect the portion of the aircraft unit O&S cost that is missile related
as well as the variable O&S cost of training at National Test Ranges.

2/ Factory training provided by contractors at their facilities to qualify
an initial cadre of skilled personnel to: (1) operate and maintain a
missile system when operationally deployed or (2) initially man Services
missile system-related training courses, is paid for by both investment
and O&M funds. Contractor instructor pay and the cost of instruction at
contractor facilities is categorized as an investment cost; the.pay of..
Service military and civilian personnel attending the factory schools
is an O&S cost.

APPENDIX B

NAVY AIR-LAUNCHED MISSILE
O&S COST ELEMENT STRUCTURE

TABLE B-1

NAVY OPERATING AND SUPPORT COST ELEMENT
STRUCTURE FOR AIR-LAUNCHED MISSILES

	Appro-priation	Budget Category[1]	Claimant[2]	Accounting Visibility[3]
o **Operations**				
1. Handling and Inspection	MPN		CINC	A
2. Operational Training	MPN, O&MN		CINC, NAVAIR NAVSEA	A, D/A
o **Below-Depot Maintenance**				
3. Organizational/AIMD Maint.	MPN, O&MN		OP-01, NAVAIR	A
4. Intermediate Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o **Installations Support**				
5. Base Operating Support	MPN, O&MN		CINC, NAVAIR NAVSEA	I
o **Depot Maintenance**				
6. Depot Maintenance	O&MN	7/A/2	NAVAIR 4104	D
o **Depot Supply and Technical Support**				
7. Supply Depot Ops	O&MN	7/E/1,2,3	NAVSUP	A/I
8. Technical Support				
Fleet Support	O&MN	7/A/2	NAVAIR 4104	D
Engineering Support	O&MN	7/A/2	NAVAIR 4104	D
Quality Evaluation	O&MN	7/A/4	NAVAIR 4104	D
Program Management	MPN, O&MN		NAVAIR	D/A
o **Second Destination Transportation**				
9. Transportation	O&MN	7/E/3	NAVSUP	A
10. Receipt, Segregation, Storage & Issue	O&MN, MPN	7/B/1	NAVSEA 04J	A
o **Personnel Support Training**				
11. Replacement Training	MPN,O&MN	8/A/2,2/E	CNET	A/I
12. Health Care	MPN,O&MN		BUMED	I
13. Personnel Support	MPN,O&MN		OP-01	I
o **Sustaining Investments**				
14. Replenishment Spares	WPN	2	NAVAIR 412	D/A
15. Modifications	WPN,O&MN	2,7/A/2	NAVAIR 412	D
16. Replenishment Ground Support Equipment	WPN		NAVAIR 4104	A

[1]7/A/2 refers to Budget Program 7, Budget Activity A, Budget Project 2

[2]Claimants: CINC - the Commander-in-chiefs of the Naval Fleets
NAVAIR - Naval Air Systems Command
NAVSEA - Naval Sea Systems Command
CNET - Chief of Naval Education and Training
NAVSUP - Naval Supply Systems Command
BUMED - Bureau of Medicine and Surgery
OP-01 - DCNO Manpower Personnel and Training

[3]D = Direct Cost with individual weapon system visibility
A = Direct Cost without individual weapon system visibility; must be allocated
I = Indirect

DEFINITIONS

1. <u>Handling and Inspection</u> - The cost of personnel and consumable material needed to perform the following tasks: removing missiles from storage; missile inspection; missile assembly; transporting missiles to the aircraft; missile uploading; and missile check out and arming prior to a captive flight or firing. This cost also includes a similar series of tasks to download the missile and return it to storage if not fired. These tasks are performed at the Naval Air Station and aboard a carrier.

2. <u>Operational Training</u> - The cost of operational firings consisting of range cost, instrumentation, target presentation, recovery, and any other support. This would also include any shipboard or NAS familiarization training for missile operational personnel.

3. <u>Organizational/AIMD Maintenance</u> - This is the cost of labor and consumable material required at the Squadron and CVA/NAS Intermediate Maintenance Activity to perform maintenance on the missile or its associated equipment. The concept of the all-up-round theoretically precludes this type of maintenance, but nevertheless, there are some maintenance functions which are performed when the missile fails a pre-flight test. Also organizational and intermediate level maintenance is required on missile-dedicated aircraft equipment.

4. <u>Intermediate Maintenance</u> - The cost of personnel, consumable material and station overhead required to perform missile and missile component checkout and repair at the Naval Weapons Stations. This includes such procedures as the functional test of the assembled round, fault isolation of the failed rounds, removal and replacement of faulty major subgroups such as the flight control group of the guidance section, and fault confirmation and other support from the Weapons Quality Evaluation Center (WQEC).

5. <u>Base Operating Support</u> - The cost of installation personnel and material necessary to directly support missile handling and inspection and below-depot maintenance personnel. Examples of installation functions which directly support the unit include food services, custodial services, supply, motor pool, payroll, ADP and communication operations. It also includes a proportional share of work center costs such as real property maintenance, etc. This cost may be estimated by utilizing the Base Operating Support factors in the <u>Navy Resource Model (NARM) Program Factors Manual</u>.

6. <u>Depot Maintenance</u> - The cost of manpower, material, and overhead needed to perform missile and missile component and support equipment maintenance at Navy and contractor repair facilities.

7. <u>Supply Depot Operations</u> - The cost of manpower and material needed to buy, store, package, manage and control supplies, spares and repair parts used in operating and maintaining missiles and missile components and support equipment.

8. <u>Technical Support</u> - The cost of a number of technically oriented programs usually centrally managed by the Systems Command or one of its field activities.

    <u>Fleet Support</u> - The cost of on-site technical personnel (usually Navy civilians) who provide technical advice and assistance in the operation and maintenance of the weapon system.

    <u>Engineering Support</u> - The cost of engineering support is comprised of two major areas - maintenance engineering and design engineering. The former consists of efforts at the various Naval engineering activities in support of the missile maintenance systems and is funded through NAVAIR 410, while the latter is concerned with engineering for the missile itself, i.e, the design and configuration matters, and is funded by the NAVAIR 510.

Quality Evaluation - The cost of the Navy Weapons Quality Program whose purpose is to monitor the status and condition of the air-launched weapon stockpile. Principal activities include maintenance/reliability/performance trend analysis, calibration of test equipment, destructive testing of missile sections, certification of NWS failures and related data collection and analysis.

Program Management - The O&S cost of missile-specific project management both at the SYSCOM level and below.

9. Transportation - This is the cost of second destination transportation which primarily consists of transporting the missiles or missile sections from the Naval Weapons Stations to the depots and back.

10. Receipt, Segregation, Storage & Issue - Personnel and material costs of on-loadings and off-loadings of ships, movement and handling of missiles to and from storage depots and NWS's, and storage.

11. Replacement Training - The variable cost of recruit and technical training including:

    o the pay of personnel in training who will replace missile operations, below-depot maintenance and installation support personnel;

    o the cost of their instruction; and

    o the pay of instructor personnel.

This cost may be estimated utilizing the factors in the Navy Resource Model (NARM) Program Factors Manual.

12. Health Care - The variable cost of providing medical support to: missile operation, below-depot maintenance and installation personnel; and training pipeline personnel including:

    o the pay of medical personnel who provide this support; and

    o the cost of medical material.

This cost may be estimated utilizing the factors in the Navy Resource Model (NARM) Program Factors Manual.

13. Personnel Support - The costs incident to the PCS of: missile operation and below-depot maintenance personnel either individually or as an organized unit; installation personnel; and training pipeline personnel. This cost may be estimated utilizing the factors in the Navy Resource Model (NARM) Program Factors Manual.

14. Replenishment Spares - The cost of procuring missile spares and repair parts which are normally repaired and returned to stock. In addition, this cost can include procurement of stock levels that are not provided by initial spares procurement.

15. Modifications - The cost of modifying missiles, missile support equipment, and training equipment that are in the operating inventory to make them safe for continued operation, to enable them to perform their missions and to improve reliability or reduce maintenance cost. This includes labor, modification kits, and consumable material.

16. Replenishment Ground Support Equipment - The cost of procuring missile ground servicing equipment, maintenance and repair shop equipment, instruments and laboratory test equipment, and other equipment items. These equipment demands are generated by a need to: (1) replace peculiar support equipment bought using procurement funds; (2) obtain common off-the-shelf ground equipment that are needed to support missile operations; and (3) replenish common ground equipment that is no longer useable.

APPENDIX C

TABLE C-1

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

Document Control Number
80000

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

1 Item Nomenclature AIM-7F Missile   Part No.   917AS101   FSN   NAVORD Drawing Number

2 Next Higher Assembly AIM-7F Missile System   Part No.

3 WBS 001-001/000   Drawing No. 917AS101   EIC   APL/CID

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character	Maintenance Requirement 2nd Character	
O - Organizational	A - Trouble Shoot C - Repair E - Test	G - Lubricate I - Adjust K - Service
I - Intermediate D - Depot	B - Remove & Replace D - Inspect F - Disassemble/Assemble	H - Calibrate J - Align L - Other

Maintenance Frequency	3rd Character		Reference 4th Character
D - Daily M - Monthly	S - Semiannually C - Overhaul Cycle		Refer to Appendix B, Worksheet IV, Block 4, for Explanation
W - Weekly Q - Quarterly	A - Annually U - Unscheduled		

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Data Code	9 Maint. Reqmt. Freq Per Year
OLU2	Ground Handling	Assembly or Flightline Operating Space	A	C,D	

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.0	Handling and Transporting Assembled Missile: The assembled missile must be transported from the assembly area to the ready for issue storage area and to the flightline or aircraft loading area. Incidental handling may also be required within the assembly area and the aircraft loading or flightline area. The missile is transported without wings and fins installed.								
1.0.1	Leading particulars: a. The weight and dimensions of the assembled missile which establish handling equipment requirements are:								

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TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

Document Control Number

80000

1 Item Nomenclature _____ Part No. _____ FSN _____ NAVORD Drawing Number _____

2 Next Higher Assembly _____ Part No. _____

3 WBS _____ Drawing No. _____ EIC _____ APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
- O - Organizational
- I - Intermediate
- D - Depot

Maintenance Requirement 2nd Character
- A - Trouble Shoot
- B - Remove & Replace
- C - Repair
- D - Inspect
- E - Test
- F - Disassemble/Assemble
- G - Lubricate
- H - Calibrate
- I - Adjust
- J - Align
- K - Service
- L - Other

Maintenance Frequency 3rd Character
- D - Daily
- W - Weekly
- M - Monthly
- Q - Quarterly
- S - Semiannually
- A - Annually
- C - Overhaul Cycle
- U - Unscheduled

4th Character
Reference
Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Data Code	9 Maint. Reqmt. Freq Per Year

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.0.2	Lift transfer missiles: a. Single missile 1. Lift/transfer complete missile from/to container/skid by attaching hoisting beam to forward launch lug and aft launch hooks and using overhead hoist. 2. Lift single missile for loading by use of lifting equipment to hoist and position missile. Do not lift by manpower.				Beam, hoisting MK 24 Mod 0 1450-HDM-0160 Overhead hoist, capacity 1000 lbs (MIN) Required lifting equipment (TBD)	7.00 6.00	2 4 1	Mt(B) AO(B) AO(I)	

TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

Document Control Number 80000

1 Item Nomenclature _____ Part No. _____ FSN _____ NAVORD Drawing Number _____

2 Next Higher Assembly _____ Part No. _____

3 WBS _____ Drawing No. _____ EIC _____ APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
O - Organizational   D - Depot
I - Intermediate

Maintenance Requirement 2nd Character
A - Trouble Shoot   C - Repair   E - Test   G - Lubricate   J - Adjust   K - Service
R - Remove & Replace   D - Inspect   F - Disassemble/Assemble   H - Calibrate   J - Align   L - Other

Maintenance Frequency 3rd Character
D - Daily   M - Monthly   S - Semiannually   C - Overhaul Cycle
W - Weekly   Q - Quarterly   A - Annually   U - Unscheduled

4th Character
Reference   Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.0.2 (Cont.)	b. Multiple missiles Lift/transfer multiple missiles in cradle, CMU-166E or MK 12 Mod 0, using HLU-216/R hoisting beam.				Overhead hoist, capacity 3500 lb Beam, Weapon Cradle, Hoisting, HLU-216/R	2.00	2	Mr(B)	
1.0.3	Transport missile a. Transport assembled missile from assembly area to flight ready storage area.				Aero 21A Weapons Skid 1740-887-0125 with Aero. 67A Adapter Fork lift truck, electric	10.0	2	Mr(B)	

(Column headers for Block 5/6/7/8/9: 5 Maintenance Requirement, 6 Facility Requirement, 7 Training Reqt Code, 8 Task Data Code, 9 Maint. Reqmt. Freq Per Year)

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TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

Document Control Number
80000

1 Item Nomenclature _____ Part No. _____ NAVORD Drawing Number _____

2 Next Higher Assembly _____ Part No. _____

3 WBS _____ Drawing No. _____ EIC _____ APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
O - Organizational
I - Intermediate   D - Depot

Maintenance Requirement
A - Trouble Shoot   C - Repair   E - Test   G - Lubricate   I - Adjust   K - Service
B - Remove & Replace D - Inspect   F - Disassemble/Assemble H - Calibrate J - Align   L - Other

Maintenance Frequency
D - Daily   M - Monthly
W - Weekly Q - Quarterly

3rd Character
S - Semiannually   C - Overhaul Cycle
A - Annually   U - Unscheduled

2nd Character

4th Character
Reference
Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Data Code	9 Maint. Reqmt. Freq Per Year

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.0.3 (Cont.)	b. Transport assembled missile from flight ready storage area to loading area.				Aero 21A Weapons Skid with Aero 67A Adapter or Aero 16B Missile Skid with Aero 42A Adapter	10.0	2	MT(B)	
	c. Transport missile within storage area.				Aero 16B Missile Skid	2.0	2	MT(B)	
	d. Transport missiles in container/cradle from supply source to storage area aboard CVA (CNU-166/R container or MK 12 Mod 0 cradle).				Aero 21A Weapons Skid with Aero 58A and Aero 91A Adapters.				

TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

Document Control Number 80000

1 Item Nomenclature AIM-7F Missile   Part No. 917AS101   FSN _____   NAVORD Drawing Number _____

2 Next Higher Assembly AIM-7F Missile System   Part No. _____

3 WBS 001-001/000   Drawing No. 917AS101   EIC _____   APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
O - Organizational   D - Depot
I - Intermediate

Maintenance Requirement
A - Trouble Shoot   2nd Character
B - Remove & Replace C - Repair   E - Test
                      D - Inspect   F - Disassemble/Assemble
G - Lubricate I - Adjust   K - Service
H - Calibrate J - Align   L - Other

Maintenance Frequency   3rd Character
D - Daily   M - Monthly   S - Semiannually   C - Overhaul Cycle
W - Weekly   Q - Quarterly A - Annually   U - Unscheduled

Reference   4th Character
Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Date Code	9 Maint. Reqmt Freq Per Year
OLU5	Assembled Missile Cleaning	Overhead Hoist Missile Assembly or Flightline Operating Space	B	D	

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.
1.3	**Clean assembled missile** An assembled missile may require cleaning to remove dirt, salt water deposits, grease, mud, and light corrosion. Cleaning may be required after downloading from aircraft, after storage, or prior to inspection and repair.				
1.3.1	**Cleaning procedures** a. The missile must be emplaced in a suitable stand or skid (Aero 21A or Aero 16B) to allow visual and physical access to all surface areas for cleaning. An overhead hoist is required to lift/transfer the missile from the cradle to the stand or skid.				Aero 21A skid with Aero 67A Adapter or Aero 16B skid with Aero 42A Adapter Beam, Hoisting MK24 Mod 0

16 Logistic Support Personnel Resource Requirements

a Task Time	b No. of Men	c Rating and Skill Level	d NEC
6.00	2	Mt(B)	

TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

1 Item Nomenclature AIM-7F Missile Part No. 917AS101 FSN NAVORD Drawing Number

2 Next Higher Assembly AIM-7F Missile System Part No.

3 WBS 001-001/000 Drawing No. 917AS101 EIC APL/CID

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character	Maintenance Requirement		
O - Organizational	A - Trouble Shoot C - Repair E - Test G - Lubricate I - Adjust K - Service		
I - Intermediate D - Depot	B - Remove & Replace D - Inspect F - Disassemble/Assemble H - Calibrate J - Align L - Other		

Maintenance Frequency	3rd Character	Reference 4th Character
D - Daily M - Monthly Q - Quarterly	S - Semiannually	Refer to Appendix B, Worksheet IV, Block 4, for Explanation
W - Weekly	A - Annually C - Overhaul Cycle U - Unscheduled	

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Data Code	9 Maint. Reqmt Freq Per Year
OEU2	Loaded Missile Functional Test		B	B	

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	4 NEC
1.5	Functional test of loaded missile (Missile on aircraft test (MOAT))				Delivery Aircraft Avionics				
	a. Perform tune check of missile to assure that the missile rear receiver will tune to the aircraft radar frequency and lock-on a simulated target doppler signal.					6.00	1	AO (I)	
	b. If missile fails test, down-load, then upload on known good station.					3.00	4 1	AO (B) AO (I)	
	c. Repeat functional test.					6.00	1	AO (I)	
	d. If missile fails test the second time, download and up-load a serviceable missile.					3.00	4 1	AO (B) AO (I)	

Document Control Number 80000

TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

Document Control Number
80000

1 Item Nomenclature __AIM-7F Missile__ Part No. __917AS101__ FSN _____ NAVORD Drawing Number _____

2 Next Higher Assembly __AIM-7F Missile System__ Part No. _____

3 WBS __001-001/000__ Drawing No. __917AS101__ EIC _____ APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
O - Organizational
I - Intermediate   D - Depot

Maintenance Requirement   2nd Character
A - Trouble Shoot   C - Repair   E - Test   G - Lubricate   I - Adjust   K - Service
B - Remove & Replace   D - Inspect   F - Disassemble/Assemble   H - Calibrate   J - Align   L - Other

Maintenance Frequency   3rd Character
D - Daily   M - Monthly   S - Semiannually   C - Overhaul Cycle
W - Weekly   Q - Quarterly   A - Annually   U - Unscheduled

Reference   4th Character
Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code C	8 Task Data Code D	9 Maint. Reqmt. Freq Per Year
OCU2	Faulty or Damaged Missile Repair	Missile Assembly or Flightline Operating Space			

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.6	Repair faulty or damaged missile					10.00 (AVG)	1	Mt(B)	
1.6.1	Missiles determined to be faulty as a result of inspection or MOAT test shall be repaired by replacing the component or components determined to be faulty.								
1.6.2	Repair at the organizational level is restricted to the following:								
	a. Touchup of illegible identification markings and color bands.					10.00	1	Mt(B)	
	b. Replacement of damaged or missing protective covers, screws, or bolts.					10.00	1	Mt(B)	

TABLE C-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA
MAINTENANCE TASK ANALYSIS

WORKSHEET IV

1 Item Nomenclature _____ Part No. _____ FSN _____ NAVORD Drawing Number _____

2 Next Higher Assembly _____ Part No. _____

3 WBS _____ Drawing No. _____ EIC _____ APL/CID _____

Document Control Number
80000

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character
O - Organizational
I - Intermediate   D - Depot

Maintenance Requirement 2nd Character
A - Trouble Shoot   C - Repair   E - Test   G - Lubricate   I - Adjust   K - Service
B - Remove & Replace   D - Inspect   F - Disassemble/Assemble   H - Calibrate   J - Align   L - Other

Maintenance Frequency
D - Daily   M - Monthly
W - Weekly   Q - Quarterly

3rd Character
S - Semiannually   C - Overhaul Cycle
A - Annually   U - Unscheduled

4th Character
Reference
Refer to Appendix B, Worksheet IV, Block 4, for Explanation

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Date Code	9 Maint. Reqmt. Freq Per Year

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.6.2 (Cont.)	c. Replacement of the following components if determined to be faulty as a result of inspection or functional test.								
	1. Lower motor fire connector.	LMFC (TBD)		1		1.00	1	Mt(B)	
	2. Wing Assembly	Wing Assy. 596791		4		1.00	1	Mt(B)	
	3. Aft fin assembly	Aft Fin Assembly 293477		4		1.00	1	Mt(B)	
	4. Shear insert	Shear Insert 115-2057		1		1.00	1	Mt(B)	
	5. Arming flag assembly	Arming Flag Assy. 2824909		1		1.00	1	Mt(B)	

TABLE G-1 (cont'd.)

HANDLING AND INSPECTION DETAILED WORKSHEETS FROM AIM-7F MEA

MAINTENANCE TASK ANALYSIS

WORKSHEET IV

DOCUMENT CONTROL NUMBER 80000

1 Item Nomenclature AIM-7F Missile   Part No. 917AS101   FSN _____   NAVORD Drawing Number _____

2 Next Higher Assembly AIM-7F Missile System   Part No. _____

3 WBS 001-001/000   Drawing No. 917AS101   EIC _____   APL/CID _____

MAINTENANCE IDENTIFICATION CODE FOR BLOCK 4

Maintenance Level 1st Character	Maintenance Requirement 2nd Character
O - Organizational	A - Trouble Shoot C - Repair E - Test G - Lubricate I - Adjust K - Service
I - Intermediate D - Depot	B - Remove & Replace D - Inspect F - Disassemble/Assemble H - Calibrate J - Align L - Other

Maintenance Frequency	3rd Character	Reference 4th Character
D - Daily M - Monthly	S - Semiannually	Refer to Appendix B, Worksheet IV, Block 4, for Explanation
W - Weekly Q - Quarterly	A - Annually C - Overhaul Cycle U - Unscheduled	

4 Maintenance Identification Code	5 Maintenance Requirement	6 Facility Requirement	7 Training Reqt Code	8 Task Data Code	9 Maint. Reqmt. Freq Per Year
IEU2	Returned Missile Functional Test	Missile Repair Facility	C	D	

10 Step No.	11 Sequential Maintenance Task	12 Repair Part Line Item Code	13 Consumable Materials	14 Quantity Used	15 Support Equip.	16 Logistic Support Personnel Resource Requirements			
						a Task Time	b No. of Men	c Rating and Skill Level	d NEC
1.8	Functionally test the returned missile.

All missiles returned to NWS/NWHU because of failure to pass the MOAT shall be subjected to a functional test in accordance with the parameters contained in AD-1298. | | | | AN/DPM-21 Test Set (Modified) For AIM-7F Missiles) | 120.0 | 2 | Mt(I) | |
| 1.8.1 | Disposition of missiles failing test

a.   If the missile fails to meet the requirements of operational checkout tests, the faulty section shall be removed and replaced with another section of the same type.   In the event that either the target seeker or flight control group is | | | | | 10.00 | 2 | Mt(B) | |

TABLE C-2

NAVAL WEAPONS STATION MAINTENANCE COSTS
FROM FY77 CONGRESSIONAL BUDGET SUBMISSION
NAVAL AIR SYSTEMS COMMAND
(FY79$)

	FY75	FY76	FYTQ	FY77
SIDEWINDER				
Quantity	1,750	1,823	551	3,591
Unit Cost	732	711	677	704
Total Cost ($K)	1,282	1,296	373	2,527
SPARROW (Air)				
Quantity	2,730	3,066	887	4,016
Unit Cost	1,191	1,155	1,100	1,144
Total Cost ($K)	3,250	3,542	965	4,592
WALLEYE I				
Quantity	983	218	213	310
Unit Cost	799	775	741	763
Total Cost ($K)	785	169	158	237
SHRIKE				
Quantity	1,813	838	14	303
Unit Cost	609	591	612	585
Total Cost ($K)	1,105	496	8	178
STANDARD ARM				
Quantity	298	34	22	206
Unit Cost	2,951	2,843	2,722	2,830
Total Cost ($K)	878	97	60	583
PHOENIX				
Quantity	200	7	3	20
Unit Cost	2,517	2,448	2,304	2,221
Total Cost ($K)	503	17	7	44

TABLE C-3

NAVAL WEAPONS STATION MAINTENANCE COSTS
FROM FY78 OSD BUDGET SUBMISSION, NAVAL AIR SYSTEMS COMMAND
(FY79$)

	FY76	FYTQ	FY77	FY78
SIDEWINDER				
Quantity	2,434	351	1,945	2,186
Unit Cost	908	942	909	919
Total Cost ($K)	2,212	331	1,769	2,009
SPARROW (Air)				
Quantity	2,103	396	1,973	1,286
Unit Cost	1,275	1,408	1,273	1,282
Total Cost ($K)	2,683	558	2,513	1,648
WALLEYE I				
Quantity	782	124	658	1,157
Unit Cost	760	780	732	806
Total Cost ($K)	595	99	482	933
WALLEYE II				
Quantity	103	25	436	611
Unit Cost	1,141	1,336	1,212	1,228
Total Cost ($K)	118	33	528	750
SHRIKE				
Quantity	696	396	1,261	1,392
Unit Cost	775	702	827	833
Total Cost ($K)	540	278	1,042	1,160
STANDARD ARM				
Quantity	35	12	149	292
Unit Cost	2,728	2,688	2,706	2,726
Total Cost ($K)	95	32	403	796
PHOENIX				
Quantity	216	—	470	793
Unit Cost	1,496	—	1,502	1,516
Total Cost ($K)	323	—	706	1,202

TABLE C-4

NAVAL WEAPONS STATION MAINTENANCE COSTS
FROM FY79 CONGRESSIONAL BUDGET SUBMISSION
NAVAL AIR SYSTEMS COMMAND
(FY79$)

	FY77	FY78	FY79
SIDEWINDER			
Quantity	1,439	1,626	1,632
Unit Cost	1,032	1,029	1,002
Total Cost ($K)	1,485	1,672	1,635
SPARROW (Air)			
Quantity	1,152	1,286	1,433
Unit Cost	1,917	1,821	1,773
Total Cost ($K)	2,207	2,343	2,541
WALLEYE I			
Quantity	717	833	577
Unit Cost	1,227	1,132	1,102
Total Cost ($K)	879	943	636
WALLEYE II			
Quantity	33	294	258
Unit Cost	1,026	1,521	1,481
Total Cost ($K)	85	448	382
SHRIKE			
Quantity	808	781	964
Unit Cost	1,318	1,397	1,360
Total Cost ($K)	1,065	1,091	1,311
STANDARD ARM			
Quantity	17	85	75
Unit Cost	19,428	3,529	3,436
Total Cost ($K)	330	300	258
PHOENIX			
Quantity	339	678	967
Unit Cost	1,647	1,594	1,552
Total Cost ($K)	558	1,081	1,501

TABLE C-5

NAVAL WEAPONS STATION MAINTENANCE - UNIT COSTS

(FY79$)

	FY77	FY78	FY79	AVG.
SIDEWINDER	1,032	1,029	1,002	1,069
SPARROW	1,917	1,821	1,773	1,837
WALLEYE I	1,227	1,132	1,102	1,154
WALLEYE II	1,026	1,521	1,481	1,343
SHRIKE	1,318	1,397	1,360	1,358
STANDARD ARM	19,428*	3,529	3,436	3,483
PHOENIX	2,150	1,594	1,552	1,765

*Not included in average

TABLE C-6

MISSILE MAINTENANCE DUE DATES

Missile	Test Internal Prior to Issue[1]	G&C Cert. Time[2]
SIDEWINDER AIM-9D/G/H	180 days	24 mos.
SPARROW III AIM-7E/E2/E3/E4	180 days	24 mos.
STANDARD ARM AGM-78/B/C/D	24 mos.	24 mos.
WALLEYE MK-1 MOD 9/2 MK-1 MOD 6/7 MK-2 MOD 0 MK-13 MOD 0 MK-5 MOD 4	210 days (pᵣ ɔr serv.) 420 day: (no serv.	36 mos.
SHRIKE AGM-45A/B	27 mos.	36 mos.
PHOENIX AIM-54	60 days	14 mos.
BULLPUP		36 mos.

Source: [1]Performance Monitoring System, 2 August 1977

[2]Performance Monitoring System, 2 September 77

TABLE C-7
INTERMEDIATE REJECT RATIO DATA

Missile	Number processed	Number Rejected	Ratio
SIDEWINDER			
AIM-9G	1,127	349	0.31
AIM-9H	2,608	117	0.04
AIM-9YH	6	3	0.50
Total	3,741	469	0.13
SPARROW			
AIM-7E2	1,167	414	0.35
AIM-7E3	606	152	0.25
AIM-7E4	562	181	0.32
AIM-7E5	187	0	0
Total	2,522	747	0.30
WALLEYE I	798	53	0.07
WALLEYE II	184	20	0.09
WALLEYE II ERDL	135	8	0.06
SHRIKE			
AGM-45A/3	376	96	0.26
AGM-45A/3A	124	23	0.19
AGM-45A/4	111	21	0.19
AGM-45A/6	135	23	0.17
AGM-45A/7	187	38	0.20
AGM-45B/3	1	0	0
AGM-45B/6	171	37	0.22
Total	1,105	238	0.22
STANDARD ARM	56	17	0.30
PHOENIX	761	184	0.24
HARPOON	216	40	0.19

TABLE C-8
FY77 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Exhibit OP-5
(Dollars in Thousands)

Department of the Navy
Naval Air Systems Command
Operation and Maintenance, Navy
FY 1977 Congressional Submission

Budget Activity 7: Central Supply and Maintenance
Budget Program A: Air Systems Technical Support
Budget Project (2): Air Launched Weapons Rework & Maintenance

FY 1975 ACTUAL
DEPOT MAINTENANCE

	NARF NORFOLK			NARF ALAMEDA			NWS INDIAN HEAD		COMMERCIAL	
	Qty	$	Man/Hours	Qty	$	Man/Hours	Qty	$	Qty	$
Sidewinder 1C(IR) AIM-9D/G/H	797	1,278	51,805	-	-	-	307	164	-	-
Sparrow III	704	1,499	61,952	469	998	44,555	514	296	-	-
Bullpup	-	-	-	-	-	-	-	-	-	-
Walleye	-	-	-	-	-	-	-	-	-	-
Shrike	-	-	-	283	311	10,754	-	-	143	275
Standard Arm	-	-	-	-	-	-	40	32	-	-
Phoenix	-	-	-	-	-	-	-	-	44	375
Condor	-	-	-	-	-	-	-	-	52	528
TOTAL		$2,777	113,757		$2,309	55,309		$492		$1,178

January 1976

TABLE C-9

FY77 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operation and Maintenance, Navy
FY 1977 Congressional Submission

Exhibit OP-5
(Dollars in Thousands)

Budget Activity 7: Central Supply and Maintenance
Budget Program A: Air Systems Technical Support
Budget Project (2): Air Launched Weapons Rework & Maintenance

FY 1976 ESTIMATE

DEPOT MAINTENANCE

	NARF NORFOLK			MARF ALAMEDA			NOS INDIAN HEAD		COMMERCIAL	
	Qty	$	Man/Hours	Qty	$	Man/Hours	Qty	$	Qty	$
Sidewinder IC(IR) AIM-9D/G/H	195	377	17,160	-	-	-	299	160	-	-
Sparrow III	434	1,100	38,192	287	727	27,483	537	421	14	38
Bullpup	-	-	-	-	-	-	-	-	-	-
Walleye	-	-	-	-	-	-	-	-	229	846
Shrike	-	-	-	320	423	13,974	69	54	-	-
Standard Arm	-	-	-	-	-	-	-	-	61	548
Phoenix	-	-	-	20	173	-	-	-	21	174
Total		$1,477	55,352		$1,323	41,457		$ 635		$1,606

January 1976

TABLE C-10

FY77 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE
Department of the Navy
Naval Air Systems Command
Operation and Maintenance, Navy
FY 1977 Congressional Submission

Budget Activity 7: <u>Central Supply and Maintenance</u>
Budget Program A: <u>Air Systems Technical Support</u>
Budget Project (2): <u>Air Launched Weapons Rework & Maintenance</u>

FY 1970 ESTIMATE

DEPOT MAINTENANCE

	NARF NORFOLK			NARF ALAMEDA			NOS INDIAN HEAD		COMMERCIAL	
	Qty	$	Man/Hours	Qty	$	Man/Hours	Qty	$	Qty	$
Sidewinder IC(IR) AIM-9D/G/H	181	357	11,713	-	-	-	90	49	-	-
Sparrow III	185	476	13,366	125	321	9,668	153	122	27	69
Bullpup	-	-	-	31	20	1,178	-	-	-	-
Walleye	-	-	-	-	-	-	-	-	14	52
Shrike	-	-	-	29	38	1,138	1	1	-	-
Standard Arm	-	-	-	-	-	-	-	-	23	213
Phoenix	-	-	-	6	53	-	-	-	6	53
Total		$833	25,079		$ 432	11,924		$172		$387

January 1976

TABLE C-11

FY77 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operation and Maintenance, Navy
FY 1977 Congressional Submission

(Dollars in Thousands)

Budget Activity 7: Central Supply and Maintenance
Budget Program A: Air Systems Technical Support
Budget Project (2): Air Launched Weapons Rework & Maintenance

	FY 1977 ESTIMATE									
	DEPOT MAINTENANCE									
	NARF NORFOLK			NARF ALAMEDA			NOS INDIAN HEAD		COMMERCIAL	
	Qty	$	Man/Hours	Qty	$	Man/Hours	Qty	$	Qty	$
Sidewinder IC(IR) AIM-9D/G/H	1,504	3,119	97,835	-	-	-	589	335	-	-
Sparrow III	975	2,631	85,829	656	1,771	62,313	703	586	244	658
Bullpup	-	-	-	626	423	23,606	-	-	-	-
Walleye	-	-	-	-	-	-	-	-	142	559
Shrike	-	-	-	25	34	949	25	21	-	-
Standard Arm	-	-	-	-	-	-	-	-	92	878
Phoenix	-	-	-	21	193	-	-	-	22	194
Total	$5,750		183,664	$2,421		86,868		$942		$2,289

January 1976

TABLE C-12

FY78 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operations, Navy
(Dollars in Thousands)

Exhibit OP-5
FY 1978 OSD/OMB

Budget Activity: 7
780178 Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework & Maintenance

DEPOT MAINTENANCE

FY 1976 Actual

	NARF NORFOLK				NARF ALAMEDA				NWS INDIAN HEAD			NAPI/ COMMERCIAL			OTHER REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/ Hours	Qty	Unit Cost ($)	Total Cost	Man/ Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	568	1,801	1,023	36,920	-	-	-	-	452	562	254	-	-	-	311	1,588
Sparrow (AIR)	337	2,463	830	32,015	519	2,533	1,315	49,305	193	782	151	-	-	-	529	2,825
Sparrow (AIR) (Mint)	137	620	85	3,014	57	565	32	1,824	-	-	-	-	-	-	-	117
Sparrow (BPD)	127	2,481	315	12,065	89	2,680	239	8,455	-	-	-	-	-	-	85	639
Sparrow (BPD) (Mint)	6	618	4	132	-	-	-	-	-	-	-	-	-	-	-	4
Sparrow (IPD)	10	2,505	25	950	-	-	-	-	-	-	-	-	-	-	-	25
Bullpup	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	48
Walleye I	-	-	-	-	-	-	-	-	-	-	-	270	1,493	403	155	558
Walleye II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9
Shrike	-	-	-	-	112	1,107	124	4,368	60	800	48	-	-	-	47	219
Standard Arm	-	-	-	-	49	4,078	200	7,350	-	-	221	17	11,111	189	41	451
Phoenix C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phoenix C	-	-	-	-	26	2,752	71	2,600	-	-	-	-	-	-	38	38
TOTAL		$2,282		85,096		$1,981		73,902			$674			$592	$1,263	$6,792

*Other rework includes rework of warheads, TDD's, wings and fins, antennas, containers, training material maintenance, repair of repairables, and MAU-1 operations.

30 September 1976

TABLE C-13

FY78 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operations, Navy
(Dollars in Thousands)

Budget Activity: 7
7801TM Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework & Maintenance

DEPOT MAINTENANCE

FY 1979 Estimate

	WARF NORFOLK				WARF ALAMEDA				NOS INDIAN HEAD			WAFI/COMMERCIAL			OTHER* REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	200	1,818	364	12,400	-	-	-	-	36	534	19	-	-	-	62	445
Sparrow (Air)	73	2,404	175	5,040	88	2,734	241	7,920	78	797	62	-	-	-	108	586
Sparrow (Air)(Mint)	28	493	14	560	25	583	14	625	-	-	-	-	-	-		28
Sparrow (RPD)	5	2,449	12	400	55	2,734	150	5,225	-	-	-	-	-	-	27	189
Sparrow (RPD)(Mint)	6	515	3	126	3	583	2	75	-	-	-	-	-	-		5
Sparrow (IPD)	25	2,515	63	2,000	-	-	-	-	-	-	-	-	-	-		63
Bullpup	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59	59
Walleye I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56	56
Walleye II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Shrike - G	-	-	-	-	36	855	31	1,080	60	797	48	-	-	-	21	113
Shrike - C	-	-	-	-	42	301	13	336	-	-	-	-	-	-		
Standard Arm	-	-	-	-	-	-	-	-	9	1,945	18	-	-	-		
Phoenix - G	-	-	-	-	5	4,182	21	750	-	-	-	-	-	-	21	39
Phoenix - C	-	-	-	-	5	2,821	14	40	-	-	-	-	-	-	27	62
TOTAL			$631	21,326			$486	16,051			$147			$0	$384	$1,648

*Other rework includes rework of warheads, TDD's, wings and fins, antennas, containers, training material maintenance, repair of repair-ables, and MMBU-1 operations.

30 September 1976

TABLE C-14

FY78 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operations, Navy
(Dollars in Thousands)

Exhibit OP-5
FY 1978 OSD/OMB

Budget Activity: 7
7801?N Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework & Maintenance

DEPOT MAINTENANCE
FY 1977 Estimate

	NARF NORFOLK				NARF ALAMEDA				NWS INDIAN HEAD			NAVI/COMMERCIAL			OTHER REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	479	1,923	921	29,698	-	-	-	-	300	596	179	-	-	-	249	1,349
Sparrow (AIR)	412	2,729	1,125	32,880	327	2,932	958	30,575	382	833	318	29	5,000	145	270	2,816
Sparrow (AIR) (Mint)	-	-	-	-	10	760	8	250	-	-	-	-	-	-	-	8
Sparrow (BPD)	30	2,464	74	2,400	41	3,036	124	3,895	-	-	-	-	-	-	67	265
Sparrow (BPD) (Mint)	23	539	12	483	27	760	21	675	-	-	-	-	-	-	-	33
Sparrow (IPD)	12	2,464	30	960	-	-	-	-	-	-	-	-	-	-	-	30
Sparrow (IPD) (Mint)	22	539	12	452	-	-	-	-	-	-	-	-	-	-	-	12
Bullpup	-	-	-	-	-	-	-	-	400	600	240	-	-	-	42	282
Walleye I	-	-	-	-	-	-	-	-	-	-	-	194	1,572	305	64	369
Walleye II	-	-	-	-	-	-	-	-	-	-	-	58	1,940	113	34	147
Shrike C	-	-	-	-	333	904	301	5,920	190	852	162	-	-	-	87	550
Shrike C	-	-	-	-	333	310	103	2,664	-	-	-	-	-	-	-	103
Standard Arm (Regrain)	-	-	-	-	-	-	-	-	88	9,600	845	37	11,864	440	87	1,372
(Repair)	-	-	-	-	-	-	-	-	23	2,042	47	-	-	-	-	47
Phoenix C	-	-	-	-	171	5,820	995	25,650	-	-	-	-	-	-	149	1,144
Phoenix C	-	-	-	-	87	3,554	309	6,960	-	-	-	-	-	-	-	309
Harpoon	-	-	-	-	-	-	-	-	-	-	-	21	3,675	77	4	81
TOTAL			$2,174	66,083			$2,819	80,659			$1,791			$1,060	$1,053	$8,917

*Other rework includes $757K for 6R COG (Repair of Repairables); balance includes rework of warheads, TDD's, wings & fins, antennas, containers, training material maintenance, and MRBU-1 operations.

30 September 1976

TABLE C-15

FY78 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Department of the Navy
Naval Air Systems Command
Operations, Navy
(Dollars in Thousands)

Exhibit OP-5
FY 1978 OSD/OMB

Budget Activity: 7
76017N Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework & Maintenance

DEPOT MAINTENANCE

FY 1978 Estimate

	NARF NORFOLK				NARF ALAMEDA				NOS INDIAN HEAD			NAFI/ COMMERCIAL			OTHER+ REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/ Hours	Qty	Unit Cost ($)	Total Cost	Man/ Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	522	2,034	1,062	32,364	-	-	-	-	300	644	193	-	-	-	272	1,527
Sparrow (AIR)	505	2,859	1,444	40,400	287	3,199	918	25,830	337	900	303	76	5,275	401	344	3,410
Sparrow (AIR)(Mini)	10	562	6	200	10	862	9	250	-	-	-	-	-	-	-	15
Sparrow (BPD)	66	2,681	177	5,280	65	3,313	215	6,175	-	-	-	-	-	-	71	463
Sparrow (BPD)(Mini)	14	588	8	294	14	862	12	350	-	-	-	-	-	-	-	20
Sparrow (IPD)	16	2,681	43	1,280	16	3,313	53	1,520	-	-	-	-	-	-	48	144
Sparrow (IPD)(Mini)	39	588	23	819	2	862	2	50	-	-	-	-	-	-	-	25
Bullpup	-	-	-	-	-	-	-	-	400	648	259	-	-	-	-	
Walleye I	-	-	-	-	-	-	-	-	-	-	-	111	1,658	184	53	312
Walleye II	-	-	-	-	-	-	-	-	-	-	-	64	1,940	124	66	250
Shrike C	-	-	-	-	306	1,030	315	9,180	-	-	-	-	-	-	32	156
Shrike C	-	-	-	-	306	387	118	2,448	-	-	-	-	-	-		
Standard Arm (Regrain)	-	-	-	-	-	-	-	-	240	920	221	-	-	-	116	770
Standard Arm (Repair)	-	-	-	-	-	-	-	-	110	10,368	1,140	-	-	-	-	
Phoenix C	-	-	-	-	296	6,339	1,876	44,400	31	2,205	68	84	12,538	1,053	102	1,140
Phoenix C	-	-	-	-	146	3,887	568	11,680	64	2,430	156	-	-	-	-	1,223
Harpoon	-	-	-	-	-	-	-	-	17	3,499	59	69	3,826	264	233	2,833
															43	366
TOTAL		$2,763		80,637		$4,086		101,883			$2,399			$2,026	$1,380	$12,654

+Other rework includes $752K for 6E COG (Repair of Repairables); balance includes rework of warheads, TDD's, wings & fins, antennas, containers, training material maintenance, and NAMU-1 operations.

30 September 1976

TABLE C-16

FY79 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

DEPARTMENT OF THE NAVY
Naval Air Systems Command
Operations, Navy

(Dollars in Thousands)

Budget Activity 7: Central Supply and Maintenance
78017N Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework and Maintenance

DEPOT MAINTENANCE

FY 1977 ACTUAL

	NARF NORFOLK				NARF ALAMEDA				NWS INDIAN HEAD			NAFI/COMMERCIAL			OTHER 1/ NWSDKK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	480	1,861	893	29,760	-				225	555	125	-			524	1,542
Sparrow (AIR)	586	2,686	1,574	46,880	353	2,775	980	33,182	192	852	164	-			192	2,910
Sparrow (AIR) (Mint)	28	549	15	588					-			-			-	15
Sparrow (BPD)	11	2,674	30	880	18	2,959	53	1,710	-			-			51	134
Sparrow (BPD) (Mint)	25	539	14	525	38	697	26	950	-			-			-	40
Sparrow (IPD)	22	2,652	58	1,760	2	2,930	6	190	-			-			-	64
Sparrow (IPD) (Mint)	6	539	3	126	-				-			-			-	3
Bullpup	-				-				-			-			-	-
Walleye I	-				-				-			297	1,637	486 1/	115 4/	601
Walleye II	-				-				-			9	2,689	24 2/	156	180
Shrike	-				-				-			-			35	35
Shrike G	-				196	763	150	5,880	-			-			20	170
Shrike C	-				311	294	91	4,043	65	865	56	-			80	227
Standard Arm	-				-				-			-			-	-
Phoenix G	-				99	6,429	636	14,850	19	10,267	195	7	11,884	84	253	1,168
Phoenix C	-				49	3,771	185	3,920	-			-			150	335
TOTAL	1,158		2,587		1,066		2,127		501		540	313		594	1,576	7,424

1/ Includes $81K for NAFI and $405K COMMERCIAL
2/ NAFI.
3/ Other Rework includes $600K for 6E COG (repair of repairables); balance includes rework of Warheads, TDD's, Wings and Fins, Antennas,
4/ Containers, Training Material Maintenance. NWSI-1 Operations and Test set Maintenance

TABLE C-17

FY79 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

Budget Justification Material
FY 1979 Congressional

DEPARTMENT OF THE NAVY
Naval Air Systems Command
Operations, Navy

(Dollars in Thousands)

Budget Activity 7: Central Supply and Maintenance
78017N Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework and Maintenance

DEPOT MAINTENANCE

FY 1978 Estimate

	MARF NORFOLK				MARF ALAMEDA				NOS INDIAN HEAD			NAFI/COMMERCIAL			OTHER[a] REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	505	2,013	1,017	31,310	287	3,061	879	25,830	300	631	189	-	-	-	321	1,527
Sparrow (AIR)	469	2,953	1,385	37,250	10	819	8	250	311	882	274	65	4,295	279	296	3,113
Sparrow (AIR) (Mtnt)	10	546	5	200	45	3,058	138	4,275	-	-	-	-	-	-	-	13
Sparrow (BPD)	66	2,953	195	5,280	10	819	8	250	-	-	-	-	-	-	67	400
Sparrow (BPD) (Mtnt)	25	571	14	525	12	3,058	37	1,140	-	-	-	-	-	-	-	22
Sparrow (IPD)	12	2,953	35	960	-	-	-	-	-	-	-	-	-	-	38	110
Sparrow (IPD) (Mtnt)	10	571	6	210	-	-	-	-	-	-	-	-	-	-	-	6
Walleye I	-	-	-	-	-	-	-	-	-	-	-	257	1,677	430	54	484
Walleye II	-	-	-	-	-	-	-	-	-	-	-	26	2,055	53	28	81
Shrike G	-	-	-	-	193	829	160	5,790	-	-	-	-	-	-	-	
Shrike C	-	-	-	-	193	364	70	1,544	-	-	-	-	-	-	-	
Standard Arm	-	-	-	-	-	-	-	-	240	902	216	-	-	-	-	534
Phoenix G	-	-	-	-	232	6,035	1,400	34,800	88	10,166	895	25	15,599	384	88	1,279
Phoenix C	-	-	-	-	116	3,685	427	9,280	64	2,357	151	-	-	-	-	2,169
Harpoon	-	-	-	-	-	-	-	-	17	3,394	58	25	3,892	97	191	155
TOTAL		$2,657		75,735		$3,127		83,159			$1,783			$1,243	$1,083	$9,893

[a]Other Rework includes $752K for 6E COG (Repair of Repairables) and $96K for 4E COG (Container Repair).

TABLE C-18

FY79 BUDGET BACK-UP DATA FOR A/L MISSILE MAINTENANCE

DEPARTMENT OF THE NAVY
Naval Air Systems Command
Operations, Navy

(Dollars in Thousands)

Budget Activity 7: Central Supply and Maintenance
78017N Maintenance Support Activities
Budget Project: Air-Launched Weapons Rework and Maintenance

DEPOT MAINTENANCE
FY 1979 Estimate

	MARF NORFOLK				NARF ALAMEDA				NOS INDIAN HEAD			NAPI/COMMERCIAL			OTHER* REWORK	TOTAL
	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Man/Hours	Qty	Unit Cost ($)	Total Cost	Qty	Unit Cost ($)	Total Cost		
Sidewinder	567	2,082	1,222	36,394	-	-	-	-	300	653	196	98	2,082	204	1,049	2,671
Sparrow (AIR)	533	3,055	1,628	42,640	263	3,165	832	30,789	397	912	362	118	4,632	547	294	3,663
Sparrow (AIR) (Mini)	48	656	22	960	35	847	30	875	-	-	-	-	-	-		57
Sparrow (BPD)	80	3,055	244	6,400	56	3,162	176	5,320	-	-	-	-	-	-	162	582
Sparrow (BPD) (Mini)	10	591	6	210	5	842	4	125	-	-	-	-	-	-		10
Sparrow (IPD)	71	3,055	216	5,680	49	3,162	156	4,655	-	-	-	-	-	-	222	494
Sparrow (IPD) (Mini)	8	591	5	168	4	867	3	100	-	-	-	-	-	-		8
Walleye I			-	-				-	-			267	1,723	460	54	514
Walleye II			-	-				-	-			106	2,114	225	28	253
Shrike C			-	-	381	858	327	11,430								761
Shrike C			-	-	393	377	148	3,144								
Standard Arm (Regrain)			-	-				-	212	933	198				88	
Standard Arm (Repair)			-	-				-	39	12,176	961					961
Phoenix C			-	-	275	6,244	1,717	41,250	22	2,237	50	31	15,599	491	48	589
Phoenix C			-	-	118	3,812	526	11,040								2,679
Harpoon			-	-				-	101	2,438	246	50	4,004	200	190	264
									18	3,511	64					
TOTAL			$3,348	92,452			$3,919	108,728			$2,077			$2,127	$2,035	$13,506

*Other rework includes $1,499 for 6E COC (Repair of Repairables) and $258K for 4E COC (Container Repair); balance includes MRAU-1 operations and test set maintenance.

January 1978

TABLE C-19

DEPOT MAINTENANCE COST PER UNIT GUIDANCE
AND CONTROL ($79)
(i.e. Total Depot Cost ÷ G&C Qty.)

Missile	FY75	FY76	FYTQ	FY77	FY78	FY79	Avg.
SIDEWINDER							
77 Submission	2,397	3,370	2,584	2,617			2,742
78 Submission		3,422	2,563	3,208	3,053		3,062
79 Submission				3,659	3,217	3,899	3,592
SPARROW (Air)							
77 Submission	3,154	3,807	3,377	3,429			3,442
78 Submission		3,430	3,305	4,134	4,028		3,724
79 Submission				3,530	4,381	4,008	3,973
WALLEYE I							
77 Submission[1]	2,517	4,521	4,279	4,483			3,950
78 Submission		2,530	—	2,166	2,351		2,349
79 Submission				2,462	—	1,925	2,194
WALLEYE II							
77 Submission	—	—	—	—			—
78 Submission		—	—	2,887	2,545		2,716
79 Submission				7,467[2]	3,314	2,387	2,851
SHRIKE							
77 Submission	1,605	1,824	1,548	2,506			1,871
78 Submission		2,393	1,559	2,233	2,626		2,230
79 Submission				892	1,471	983	1,115
STANDARD ARM							
77 Submission	11,352	10,995	10,668	10,869			10,971
78 Submission		32,838	—	43,680	29,364		35,294
79 Submission					54,426[2]	15,347	15,347
PHOENIX							
77 Submission	13,444	10,359	10,176	10,251			11,058
78 Submission		5,043	7,143	9,678	9,991		7,964
79 Submission				7,473	6,631	6,487	6,863
HARPOON							
77 Submission							
78 Submission			—	—	4,393	5,537	4,965
79 Submission				—	6,596	5,280	5,938

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[1]WALLEYE I and II combined.

[2]Not included in average.

TABLE C-20

UNIT COSTS TO REPAIR GUIDANCE AND CONTROL SECTIONS AT THE DEPOT ($79)

Missile	FY75	FY76	FYTQ	FY77	FY78	FY79	Avg.
SIDEWINDER							
77 Submission	2,123	2,366	2,272	2,362			2,280
78 Submission		2,204	2,094	2,190	2,164		2,163
79 Submission				2,120	2,141	2,082	2,114
SPARROW							
77 Submission	2,820	3,102	2,962	3,074			2,990
78 Submission		3,067	2,770	3,211	3,172		3,055
79 Submission				3,098	3,186	3,090	3,125
WALLEYE I							
77 Submission	—	—	—	—			—
78 Submission		1,827	—	1,790	1,764*		1,794
79 Submission				1,864	1,784	1,723	1,790
WALLEYE II							
77 Submission	—	—	—	—			—
78 Submission		—	—	2,210	2,064*		2,137
79 Submission				3,063	2,186	2,114	2,454
SHIRKE							
77 Submission	1,456	1,618	1,509	1,549			1,533
78 Submission		1,355	1,408	1,382	1,505		1,413
79 Submission				1,400	1,268	1,247	1,305
STANDARD ARM							
77 Submission	—	—	—	—			—
78 Submission		13,600	—	—	13,338		13,469
79 Submission				13,535	—	—	13,535
PHOENIX							
77 Submission	—	10,588	10,291	10,467			10,449
78 Submission		6,769	8,064	8,685	8,784		8,076
79 Submission				9,445	8,378	8,156	8,660
HARPOON							
77 Submission	—	—	—	—			—
78 Submission		—	—	—	4,070		4,070
79 Submission					4,140	4,004	4,072

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*Commercial

TABLE C-21

DEPOT LEVEL MANHOURS FOR REPAIR OF
GUIDANCE AND CONTROL SECTIONS

Missile	FY75	FY76	FYTQ	FY77	FY78	FY79
SIDEWINDER						
77 Submission	65	88	65	65		
78 Submission		65	62	62	62	
79 Submission				62	62	62
SPARROW						
77 Submission	91	91	74	91		
78 Submission		95	85	86	84	
79 Submission				85	83	92
SHRIKE						
77 Submission	38	44	39	38		
78 Submission		39	38	38	38	
79 Submission				43	38	38
PHOENIX						
77 Submission						
78 Submission		250	230	230	230	
79 Submission				230	230	230

DEPOT LABOR RATES FOR MISSILE REPAIR
(then year dollars)

Fiscal Year	Rate	Source
73	$17.75	Industrial Performance Summary for Naval Air Rework Facilities, 1973
74	20.54	Industrial Performance Summary for Naval Air Rework Facilities, 1974
75	23.25	Industrial Performance Summary for Naval Air Rework Facilities, 1975
76	29.62	Industrial Performance Summary for Naval Air Rework Facilities, 1976
77	32.45	FY79 Congressional Budget Submission
78	36.40	FY79 Congressional Budget Submission
79	36.12	FY79 Congressional Budget Submission

TABLE C-22

DEPOT MAINTENANCE COSTS
(OTHER THAN REPAIR OF GUIDANCE & CONTROL)

(79$)

Rocket Motor Repair (Unit Cost)	FY75[1]	FY76[2]	FYTQ[3]	FY77[4]	FY78[5]	FY79[6]
SIDEWINDER	707	688	615	632	671	653
SPARROW	763	957	918	970	938	912
SHRIKE	1,060	979	918	985	960	933
STANDARD ARM				11,694	10,815	10,010
PHOENIX					2,507	2,438
HARPOON					3,611	3,511

NAFI/Commercial Repair (Unit Cost)						
SIDEWINDER						2,082
SPARROW					4,569	4,632
WALLEYE	2,513	1,827		1,899	1,816	1,836
STANDARD ARM	11,289	13,600		13,535	16,595	15,599
PHOENIX	13,449					
HARPOON					4,140	4,004

Other Depot Costs (per G&C unit)						
SIDEWINDER		671	357	1,243	677	1,787
SPARROW		617	582	232	417	369
WALLEYE		743		711	309	220
SHRIKE		514	310	221	485	114
STANDARD ARM		2,952		41,164	—	1,548
PHOENIX		621	3,111	1,155	876	460

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[1] FY77 Congressional Budget Submission

[2,3] FY78 OSD Budget Submission

[4,5,6] FY79 Congressional Budget Submission

TABLE C-23
FLEET SUPPORT COSTS
(Thous. of 79$)

Missile	FY75	FY76	FYTQ	FY77	FY78	FY79	Avg.
SIDEWINDER							
77 Submission	265	268					267
78 Submission		262	62	295	350		298
79 Submission				292	311	217	273
SPARROW							
77 Submission	252	258					255
78 Submission		252	62	334	293		290
79 Submission				336	240	251	276
WALLEYE I							
77 Submission*	132	208					170
78 Submission		179	36	123	150		150
79 Submission				85	113	88	95
WALLEYE II							
77 Submission							
78 Submission		29	13	50	100		59
79 Submission				33	76·	66	58
SHRIKE							
77 Submission	212	245					229
78 Submission		245	56	228	254		241
79 Submission				154	178	188	173
STANDARD ARM							
77 Submission	146	208					177
78 Submission		208	50	205	200		204
79 Submission				33	62	125	73
PHOENIX							
77 Submission	159	171					165
78 Submission		171	40	171	246		193
79 Submission				199	151	156	169
HARPOON							
77 Submission	—						
78 Submission		—	—	89	250		170
79 Submission				57	79	156	97

*Data is for WALLEYE I and II.

TABLE C-24

ENGINEERING SUPPORT (NAVAIR 410)
(Thous. of FY79$)

Missile	FY75	FY76	FYTQ	FY77	FY78	FY79	Avg.
SIDEWINDER							
77 Submission	493	574					534
78 Submission		574	120	708	871		699
79 Submission				791	662	941	798
SPARROW							
77 Submission	497	802					650
78 Submission		802	168	896	916		856
79 Submission				871	777	961	870
WALLEYE I							
77 Submission*	397	367					382
78 Submission		316	60	203	203		241
79 Submission				261	295	229	262
WALLEYE II							
77 Submission							
78 Submission		51	21	82	138		90
79 Submission				132	216	177	175
SHRIKE							
77 Submission	405	441					423
78 Submission		441	123	243	288		337
79 Submission				313	650	350	438
STANDARD ARM							
77 Submission	503	367					435
78 Submission		367	82	344	420		373
79 Submission				442	494	425	454
PHOENIX							
77 Submission	559	343					451
78 Submission		343	81	319	455		369
79 Submission				405	793	492	563
HARPOON							
77 Submission							
78 Submission		—	—	178	567		373
79 Submission				184	793	613	530

*WALLEYE I and II combined.

TABLE C-25

ENGINEERING SUPPORT (NAVAIR 510)
(Thous. of FY79$)

Missile	FY76 & TO	FY77	FY78	FY79	Avg.
SIDEWINDER					
77 Actual	817	574	677	686	689
78 Plan	—	1,704	1,353	1,272	
SPARROW					
77 Actual	256	227	273	675	388
78 Plan		523	564	1,464	
WALLEYE I					
77 Actual	56	60	99	69	71
78 Plan		184	196	163	
WALLEYE II					
77 Actual	28	31	50	35	36
78 Plan		92	98	81	
SHRIKE					
77 Actual	210	186	279	195	218
78 Plan		534	556	455	
STANDARD ARM					
77 Actual	319	277	245	263	276
78 Plan		540	609	549	
PHOENIX					
77 Actual	52	67	151	680	238
78 Plan		239	124	1,107	
HARPOON					
77 Actual				154	154
78 Plan				250	

TABLE C-26

QUALITY EVALUATION COSTS
(79$ in thous.)

Missile	FY77	FY78	FY79	Avg.
SIDEWINDER	465	449	480	465
SPARROW	365	425	399	397
WALLEYE I	184	200	142	175
WALLEYE II	92	100	70	88
SHRIKE	303	332	337	324
STANDARD ARM	102	47	119	90
PHOENIX	168	246	390	268
HARPOON	201	268	315	262

TABLE C-27

Second Destination Transportation

Department of the Navy
Operations, Navy

Exhibit OP-5
FY 1977 Congressional Submission

JUSTIFICATION BY SUBPROGRAM

Major Claimant CNM (NAVSUP)

Program Element: 78010N (Second Destination Transportation - Summary)

		FY 1975 Actual Workload	($000)	FY 1976 Estimate Workload	($000)	FY 197Q Estimate Workload	($000)	FY 1977 Estimate Workload	($000)
1. Transportation									
a. MTMC			58,636		76,886		19,221		69,293
Channel Traffic Cargo	(S/Tons)	44,450	51,264	50,477	69,658	12,619	17,414	51,083	62,459
Overseas Rail	(S/Tons)	3,825	2,544	4,543	4,928	1,160	1,247	4,696	4,568
Special Assignment			4,828		2,240		560		2,267
b. MSC			61,575		65,084		16,471		60,060
Ocean Cargo	(H/Tons)	693,125	40,770	712,202	46,685	178,050	11,671	720,748	43,466
Navy Exchange Cargo	(M/Tons)	245,324	13,473	274,535	16,351	68,634	4,088	277,830	13,776
Overseas Rail	(H/Tons)	16,014	787	14,544	800	3,636	200	14,719	745
Per Diem			3,417		2,048		512		2,073
POL (Japan)			3,128		-0-		-0-		-0-
c. Other			66,015		78,985		19,746		79,748
Commercial Overseas Mail			20,723		21,812		5,453		22,013
Inland Commercial Cargo	(S/Tons)	323,175.	33,921	403,955	41,765	100,909	10,441	408,602	42,266
QUICKTRANS			11,371		15,408		3,852		15,404
Subtotal - Transportation			186,226		221,755		55,438		209,101
2. Terminal Services	(H/Tons)	1,197,725	12,109	1,087,472	11,904	271,868	2,976	1,100,522	12,047
Total			198,335		233,659		58,414		221,149
Available Funding			198,335		218,865		53,503		207,089
Deficiency			-0-		14,794		4,911		14,059

TABLE C-28

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS, Concord, CA
Destination: NOS, Indianhead, MD
Distance: 2,793 miles

All costs are $ per hundred
weight unless labeled otherwise

	TL	DROM	MIXED	Dual Driver Protective Service (per shipment)
		— LTL —		
Class A Explosive				
Rate	10.32	36.71	64.78	516.22
Min weight	38,000	2,500	5,000	
Class B Explosive				
Rate	10.32	36.71	64.78	516.22
Min weight	38,000	2,500	5,000	
Class C Explosive				
Rate	10.32	36.71	64.78	516.22
Min weight	38,000	2,500	5,000	
INERT				
Rate	11.61		27.09	
Min weight	24,000		min.chg.	
LTL under 500 lbs			18.50[1]	
LTL 500-2,000			18.06	
LTL 2,000-5,000			16.77	
LTL 5,000-10,000			16.26	
LTL 10,000-15,000			14.13	
LTL over 15,000			12.57	

[1]Plus Single Shipment Charge of $2.93 per cwt.

Key
TL   – Truck load
LTL   – Less than truck load
DROM – Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED – Components are not isolated from rest of shipment.

Metric Conversion: 1 mile – 1.6093k ; 1 lb. = 0.453kg.

TABLE C-29

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS Concord, CA
Destination: NWS Earle, NJ
Distance: 2,901 miles

All costs are $ per hundred
weight unless labeled otherwise

	TL			— LTL —		
				DROM	MIXED	Dual Driver Protective Service (per shipment)
Class A Explosive						
Rate	16.23	14.75	14.73	38.63	68.34	545.90
Min weight	30,000	38,000	42,000	2,500	5,000	
Class B Explosive						
Rate		10.85		38.63	68.34	545.90
Min weight		38,000		2,500	5,000	
Class C Explosive						
Rate		10.85		38.63	63.34	545.90
Min weight		38,000		2,500	5,000	
INERT						
Rate		10.93			29.07[1]	
Min weight		24,000			min.chg.	
LTL under 500 lbs					18.50	
LTL 500-2,000					18.06	
LTL 2,000-5,000					16.77	
LTL 5,000-10,000					16.26	
LTL 10,000-15,000					14.13	
LTL over 15,000					12.57	

---

[1]Plus Single Shipment Charge of $2.93 per cwt.

Key
TL — Truck Load
LTL — Less than truck load
DROM — Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED — Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-30

REPRESENTATIVE TRANSPORTATION RATES

Origin: NARM, Alameda, CA
Destination: NWSC, Crane, IN
Distance: 2,255 miles

All costs are $ per hundred
weight unless labeled otherwise

| | | TL | | | — LTL — | |
				DROM	MIXED	Dual Driver Protective Service (per shipment)
Class A Explosive						
	Rate	5.44	5.37	5.34	32.18		442.02
	Min weight	38,000	40,000	42,000	2,500		
Class B Explosive						
	Rate	5.44	5.37	5.34	32.18		442.02
	Min weight	38,000	40,000	42,000	2,500		
Class C Explosive						
	Rate	5.44	5.37	5.34	32.18		442.02
	Min weight	38,000	40,000	42,000	2,500		
INERT						
	Rate	4.79	4.47	4.27		24.76[1]	
	Min weight	30,000	38,000	40,000		min.chg.	
	LTL under 500 lbs					15.71	
	LTL 500-2,000					15.34	
	LTL 2,000-5,000					14.16	
	LTL over 5,000					13.93	

---

[1]Plus Single Ship Charge of $2.93 per cwt.

Key
TL   - Truck load
LTL - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED- Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-31
REPRESENTATIVE TRANSPORTATION RATES

Origin: NARF, Alameda, CA
Destination: NWS, Yorktown, VA
Distance: 2,903 miles

All costs are $ per hundred weight unless labeled otherwise

		TL			— LTL —		
					DROM	MIXED	Dual Driver Protective Service (per shipment)
Class A Explosive							
	Rate	16.23	14.75	14.73	38.63	68.34	545.90
	Min weight	30,000	38,000	42,000	2,500	5,000	
Class B Explosive							
	Rate		10.85		38.63	68.34	545.90
	Min weight		38,000		2,500	5,000	
Class C Explosive							
	Rate		10.85		38.63	68.34	545.90
	Min weight		38,000		2,500	5,000	
INERT							
	Rate	8.77	7.01	6.07	26.43[1]		
	Min weight	20,000	30,000	30,000	min.chg.		
	LTL under 500 lbs				15.93		
	LTL 500-2,000				15.59		
	LTL 2,000-5,000				14.41		
	LTL 5,000-10,000				14.11		
	LTL 10,000-15,000				12.14		
	LTL over 15,000				10.82		

---

[1]Plus Single Ship Charge of $2.93 per cwt.

Key
TL   - Truck load
LTL   - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED - Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-32

REPRESENTATIVE TRANSPORTATION RATES

Origin: NARM, Alameda, CA
Destination: NAS, Miramar, CA
Distance: 506 miles

All costs are $ per hundred
weight unless labled otherwise

	TL		LTL (per shipment)		Signature[1] Security Service (per shipment)
	Min. Wt.	Rate	Weight	Rate	
Class A Explosive					
	36,000	1.60	2500-5000	295.00	14.00
	40,000	1.50	5000-10000	340.00	14.00
Class B Explosive					
	36,000	1.60	2500-5000	295.00	14.00
	40,000	1.50	5000-10000	340.00	14.00
Class C Explosive					
	35,000	1.60	2500-5000	295.00	14.00
	40,000	1.50	5000-10000	340.00	14.00
INERT					
	10,000	1.15	0-100	10.85	
	15,000	1.02	100-150	15.45	
	20,000	0.87	150-200	18.10	
	30,000	0.67	200-250	21.10	
	40,000	0.51	250-300	24.00	
	45,000	0.47	300-400	28.60	
			400-500	33.45	
	50,000	0.46	over 500	37.90	

---

[1]For dual driver protective service add $16.13 per hr. Minimum charge is $85.00.

Key

TL — Truck load
LTL — Less than truck load
DROM — Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED — Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-33

REPRESENTATIVE TRANSPORTATION RATES

Origin: NARF, Alameda, CA
Destination: NWS, Seal Beach, CA
Distance: 417 miles

All costs are $ per hundred
weight unless labled otherwise

| | TL | | LTL | | Signature[1] |
| | | | (per shipment) | | Security Service (per shipment) |
	Min. Wt.	Rate	Weight	Rate	
Class A Explosive	40,000	0.95	2500-5000	270.00	14.00
			5000-10000	320.00	14.00
Class B Explosive	40,000	0.95	2500-5000	270.00	14.00
			5000-10000	320.00	14.00
Class C Explosive	40,000	0.95	25000-5000	270.00	14.00
			5000-10000	320.00	14.00
INERT	10,000	1.10	0-100	9.45	
	15,000	0.86	100-150	12.65	
	20,000	0.76	150-200	14.65	
	30,000	0.55	200-250	17.20	
	40,000	0.43	250-300	19.15	
	45,000	0.40	300-400	22.75	
	50,000	0.38	400-500	25.65	
			over 500	28.45	

[1]For dual driver protective service add $16.13 per hr. Minimum charge is $85.00.

Key

TL   - Truck Load
LTL - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from
       the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED - Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-34

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS, Charleston, SC
Destination: NARF, Alameda, CA
Distance: 2,763 miles

All costs are $ per hundred
weight unless labled otherwise

	TL			LTL		
				DROM	MIXED	Dual Driver Protective Service (per shipment)
Class A Explosive						
Rate	15.40	14.00	13.38	36.71	64.28	516.22
Min. Weight	30,000	38,000	42,000	2500	5000	
Class B Explosive						
Rate		10.85		36.71	64.28	516.22
Min. Weight		28,000		2500	5000	
Class C Explosive						
Rate		10.85		36.71	64.28	516.22
Min. Weight		38,000		2500	5000	
INERT						
Rate	9.79	7.48	6.18[1]		28.13	
Min. Weight	20,000	30,000	40,000		Min.chg.	
LTL under 500 lbs.					17.38[2]	
LTL 500 - 1000					17.00	
LTL 1000 - 2000					16.51	
LTL 2000 - 5000					15.76	
LTL 5000 - 9999					15.45	

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[1]Overflow rate of $13.25 wigh 15,000 minimum applies when first truck is loaded.

[2]Plus Single Shipment Charge of $293 per cwt.

Key
TL   - Truck Load
LTL   - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED - Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-35

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS Yorktown, VA
Destination: NARF, Alameda, CA
Distance: 2,903 miles

All costs are $ per hundred
weight unless labeled otherwise

	TL			DROM	MIXED	Dual Driver Protective Service (per shipment)
Class A Explosive						
Rate	16.23	14.75	14.73	38.63	68.34	545.90
Min. Weight	30,000	38,000	42,000	2500	5000	
Class B Explosive						
Rate	10.85			38.63	68.34	545.90
Min. Weight	38,000			2500	5000	
Class C Explosive						
Rate	10.85			38.63	68.34	545.90
Min. Weight	38,000			2500	5000	

The TL/LTL header spans: TL over the three TL columns; LTL over DROM and MIXED.

INERT

Rate	— [1]	26.43[2]
Min. Weight		Min.chg.
LTL under 500 lbs		15.93
LTL 500 – 2000		15.59
LTL 2000 – 5000		14.41
LTL 5000 – 10,000		14.11
LTL 10,000 – 15,000		12.14
LTL over 15,000		10.82

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[1] TL rate quoted was higher than LTL, therefore use LTL.

[2] Plus Single Shipment Charge of $2.93 per cwt.

<u>Key</u>
TL   – Truck Load
LTL   – Less than truck load
DROM – Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED – Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-36

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS, Yorktown, VA
Destination: NOS, Indianhead, MD
Distance: 170 miles

All costs as $ per hundred
weight unless labeled otherwise

	TL		LTL				Dual Driver
			DROM		MIXED		Protective Service
	Min. Wt.	Rate	Wt.	Rate	Wt.	Rate	(per shipment)
Class A Explosive	16,000	3.63	2500	12.18	5000	10.89	143.10
	22,000	2.86					
	30,000	2.42					
	38,000	2.20					
	42,000	2.18					
	40,000	1.46[1]					
Class B Explosive	16,000	3.63	2500	12.18	5000	10.89	143.10
	22,000	2.86					
	30,000	2.42					
	38,000	1.98					
	40,000	1.46[1]					
Class C Explosive	16,000	3.63	2500	12.18	5000	10.89	143.10
	22,000	2.86					
	30,000	2.42					
	38,000	1.98					
INERT	14,000	3.92			Min.chg.	30.67[2]	
	16,000	3.60			under 500	16.03	
	23,000	3.44			500 - 1000	13.42	
	31,000	2.69			1000 - 2000	10.51	
	35,000	2.43			2000 - 5000	8.90	
	40,000	2.15			5000 - 9999	6.44	

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[1] To Naval Propellant Plant only

[2] Per shipment

Key
TL   - Truck Load
LTL   - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED - Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-37

REPRESENTATIVE TRANSPORTATION RATES

Origin: NWS Yorktown, VA
Destination: NWS, Charleston, SC
Distance: 432 miles

All costs are $ per hundred
weight unless labeled otherwise

| | TL | | LTL | | | | Dual Driver Protective Service (per shipment) |
| | | | DROM | | MIXED | | |
	Min. Wt.	Rate	Wt.	Rate	Wt.	Rate	
Class A Explosive	16,000	5.61	2500	14.94	5000	16.55	143.10
	22,000	4.42					
	30,000	3.74					
	38,000	3.40					
	42,000	3.38					
Class B Explosive	16,000	5.61	2500	14.94	5000	16.55	143.10
	22,000	4.42					
	30,000	3.74					
	38,000	3.06					
Class C Explosive	16,000	5.61	2500	14.94	5000	16.55	143.10
	22,000	4.42					
	30,000	3.74					
	38,000	3.06					
INERT	20,000	1.38				9.00[1]	
	30,000	1.25			Under 1000	4.64[2]	
					1000 - 2000	3.41	
					2000 - 5000	2.99	
					5000 - 10,000	2.10	

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[1]Minimum Charge
[2]Plus Single Shipment Charge of $3.24 per cwt.

Key
TL   - Truck load
LTL   - Less than truck load
DROM - Components are shipped inside a dromedary unit and therefore isolated from the rest of the shipment. Each dromedary used has a 5000 lb. maximum.
MIXED - Components are not isolated from rest of shipment.

Metric Conversion: 1 mile = 1.6093km; 1 lb. = 0.453kg.

TABLE C-38

RECEIPT, SEGREGATION, STORAGE & ISSUE COSTS
FOR AIR-LAUNCHED MISSILES
(FY79$ in Thous.)

Cost	NTS Keyport	NWS Charleston	NWS Concord	NWS Earle	NWS SealBeach	NWS Yorktown	Total
FY78 2nd Half							
Off-loads	0.3	0.2	37.1	0.3	11.8	50.8	100.5
On-loads	0.1	0.3	69.3	0.4	30.0	96.4	196.5
Receipts	1.3	0.3	31.4	0.1	23.2	41.6	97.9
Issues	0.9	0.6	48.7	1.0	111.7	178.0	340.9
TOTAL	2.6	1.4	186.5	1.8	176.7	366.8	735.8
FY79							
Off-loads	0.4	0.6	91.8	0.7	22.3	104.6	220.4
On-loads	0.4	0.7	104.8	0.5	45.8	145.8	298.0
Receipts	25.9	1.1	82.7	0.3	45.9	85.7	241.6
Issues	2.4	1.5	87.7	1.2	166.4	249.2	508.4
TOTAL	29.1	3.9	367.0	2.7	280.4	585.3	1,268.4
FY80							
Off-loads	0.7	0.8	67.6	0.4	6.1	107.2	182.8
On-loads	3.7	0.8	116.0	0.3	51.0	101.7	273.5
Receipts	2.9	1.3	60.9	0.2	14.4	87.7	167.4
Issues	24.1	1.8	73.2	0.8	189.9	156.9	446.7
TOTAL	31.4	4.7	317.7	1.7	261.4	453.5	1,070.4
TONNAGE*							
78 2nd Half Receipts	5	12	461	4	448	771	1,701
Issues	4	15	804	6	486	1,830	3,144
79 Receipts	9	38	1,185	8	798	1,521	3,559
Issues	8	35	1,273	7	696	2,648	4,667
80 Receipts	11	50	943	5	236	1,685	2,930
Issues	93	43	1,511	4	838	1,996	4,485

*Short tons

TABLE C-39

6E-COG REPLENISHMENT SPARES FOR AIR-LAUNCHED MISSILES
(FY79$ in thous.)

	FY76/TQ	FY77	FY78	FY79	FY80	FY81	FY82	FY83	FY84
SIDEWINDER	178	115	211	958	1,423	1,374	1,380	1,351	1,367
SPARROW	1,226	79	105	179	384	422	366	310	323
SHRIKE	115	51	238	408	604	583	581	569	562
STANDARD ARM	13	98	102	271	402	389	388	378	374
PHOENIX	438	34	69	103	203	191	246	248	325
HARPOON	—	—	—	—	77	112	108	141	148
HARM	—	—	—	—	—	—	102	300	279
OTHER	149	51	89	181	50	108	165	73	29
TOTAL	2,119	428	814	2,100	3,143	3,179	3,336	3,370	3,407

TABLE C-40

4E-COG REPLENISHMENT SPARES FOR AIR-LAUNCHED MISSILES
(FY79$ in thous.)

	FY76/TQ	FY77	FY78	FY79	FY80	FY81	FY82	FY83	FY84
SIDEWINDER	1,417	812	1,937	1,637	1,749	1,605	1,500	1,500	1,500
SPARROW	210	85	227	591	210	216	240	240	240
WALLEYE	—	—	126	118	118	118	118	118	118
SHRIKE	12	11	319	328	228	211	201	201	201
STANDARD ARM	—	—	—	3	3	3	3	3	3
HARPOON	—	—	3	201	234	234	234	234	234
TOTAL	1,639	908	2,612	2,878	2,542	2,387	2,272	2,296	2,296

TABLE C-41

AIR-LAUNCHED MISSILE MODIFICATION PROCUREMENT
(FY79$ in Thous.)

	Prior Years Qty.	$K	78 Qty.	$K	79 Qty.	$K	80 Qty.	$K	Total Prog. Qty.	$K
AIM-7E/2 Motor Regrain.	1,590	2,413	441	750	500	850	—	—	2,531	4,013
7F Auto-pilot Sep.	—	—	—	—	290	875	800	2,400	1,090	3,270
TOTAL AIM-7	1,590	2,413	441	750	790	1,725	800	2,400	3,441	7,283
AIM-9L HiCapacity Gyro*	—	—	—	—	145	300	400	900	900	2,020
AIM-9L Cold Gas Servo Sys.*	—	—	—	—	—	—	340	500	940	1,450
TOTAL AIM-9	—	—	—	—	145	300	740	1,400	1,840	3,470
AIM-54 (ECP-57)*	438	876	586	1,170	182	515	191	590	1,397	3,151
AIM-54 Life/Oper.Time Impr.*	—	—	200	1,000	200	1,000	600	3,000	1,600	8,000
AIM-54 NARF Test Set Rel. Impr.	—	—	—	—	1	1,300	1		1	1,450
AIM-54 DSM-130 Test Capab.	—	—	—	—	3	835	7	1,946	10	2,781
AIM-54 G&C Sys.Test Set AIM 54C Capab.	1	1,733	—	—	1	1,564	—	—	2	3,297
TOTAL AIM-54	439	2,609	786	2,170	387	5,214	798	5,536	3,010	18,679
AGM-45 A/B Warhead Mod.*	—	—	—	—	—	—	400	1,100	400	1,100
AGM-45 A/B Guidance Sec.* Boresight Mod.	—	—	—	—	—	—	200	200	200	200
AGM-45 A/B MK39 Mod 3,4 RM Regrain. to 7*	—	—	—	—	325	700	325	700	650	1,430
TOTAL AGM-45	—	—	—	—	325	700	925	2,000	1,250	2,730

*Requires O&MN installation funds.

TABLE C-42

AIR-LAUNCHED MISSILE O&MN INSTALLATION OF MODIFICATION
(FY79$ in Thous.)

Missile	FY76	FYTQ	FY77	FY78	FY79
SIDEWINDER					
78 Submission				5	
79 Submission				5	10
SPARROW					
78 Submission			738	681	
79 Submission			877	659	626
STANDARD ARM					
78 Submission					
79 Submission				15	
PHOENIX					
78 Submission			310	248	
79 Submission				169	276

APPENDIX D

METRIC CONVERSION CHART

TABLE D-1
METRIC CONVERSION CHART

2.2046	Pounds per Kilogram
0.4535	Kilograms per Pound
0.6214	Miles per Kilometer
1.6093	Kilometers per Mile
1209	Speed (Mach) in Kilometers/hour
0.9144	Meters per Yard
1.0936	Yards per Meter
39.3700	Inches per Meter
0.0254	Meters per Inch

APPENDIX E

USER'S GUIDE

USER'S GUIDE

This appendix is included to provide the users of this estimating model with a simple guide. It is designed to provide sufficient guidance for the uninitiated analyst and to provide an expedient reference for the experienced analyst.

The first step in preparing a missile O&S estimate with this model is to read the entire report thoroughly including the reference material, if necessary. This should provide a good basis of understanding of air-launched missile O&S costs. Table E-1 provides an alphabetical listing of all the variables defined in this report. The analyst should be familiar with all of them.

The second step is to become as familiar as possible with the missile system, its operational and support concepts, and other pertinent data. Table E-2 provides a listing of the variables defined in this report, arranged according to their most probable source. This table should enable the uniniti- ated analyst to gather all the required data with a single request. Obviously, situations vary and, in some instances, the analyst may have to revert to a second or third source. Also, the values of some variables are simply not defined early in the program and the analyst must solicit an informed estimate or refer to the information and examples contained in this report and make his own informed estimate. These types of problems are not unusual, especially if the system is very early in the acquisition cycle.

Table E-3 contains a listing of the cost elements and the Cost- Estimating Relationships (CER's). This provides a summary of the estimating procedures for the experienced analysts. Table E-4 provides a listing of the Cost Element Structure (CES) and points of contact for each element. Since

the situation in the fleet changes often, the analyst may want to update cost data, or discuss support policy as part of the O&S analysis. This table provides a starting point for finding the responsible individual.

Life Cycle Costs

This report was written to provide a capability for estimating _average_ _annual_ O&S costs for air-launched missiles. It is possible to convert the average annual cost into life cycle cost in several ways.

The first is simply to perform the entire analysis procedure for each year, computing the annual workloads, unit costs and all other variables year-by-year. A second method is to compute a single average annual O&S cost and multiply it by the number of years the system is deployed. The average annual cost can be multiplied by an appropriate fraction for each year that the system is not fully deployed.

ᵀt is realized that these are simplistic methodologies and that there are more complex and sophisticated issues involved in computing life cycle O&S costs, but they will not be discussed further in this report.

TABLE E-1

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
AAD	A dummy variable which takes the following values; 0, if the missile is an air-to-surface missile 1, if the missile is an air-to-air missile	8.1, 8.3
ACMRT	the total annual time spent training on the Advanced Combat Maneuvering Range (hours)	2
AF	the annual NWS workload resulting from missile failures, determined by BIT check and visual inspection.	4
AFRR	the failure rate at the NWS of missiles which were returned to the NWS as observed failures in the fleet	4
ANSA	the average number of missiles stored afloat	4
ANSS	the average number of missiles stored ashore	4
ASR	the afloat storage recertification time (maintenance due date – in years)	4
ASW	the average section weight (thous. of kg.)	9
BE	the number of base operating enlisted personnel necessary to provide BOS services to missile system personnel	5
BO	the number of base operating officers necessary to provide BOS services to missile system personnel	5
BOM	the O&M funds required to provide BOS services to missile system personnel (FY79$K)	5
BOS	the total cost (O&MN and MPN) of base operating support (FY79$K)	5
CAC_{1000}	the cumulative average hardware cost of the first one thousand missiles procured (FY79$K)	5, 16
CF	the annual number of captive flights	1
CFD	the average captive flight duration (hours)	4
CFFR	the captive flight failure rate (MTBF in hours)	4
CI	the unit cost of installing a modification kit	15
CM	the cost of consumable material used in handling and inspection tasks	1
CMK	the unit cost of a modification kit (FY79$K)	15
CMA	the annual cost of consumable material for missile-dedicated aircraft equipment maintenance (FY79$K)	3
CP_1	the annual cost of paying one Program Management person in the 1th grade (FY79$K)	8.4
DBE	the number of direct enlisted plus base operating enlisted (computed in Element 5) required to support the weapon system	5, 11, 13
DBO	the number of direct officers plus base operating officers required to support the weapon system	5, 11, 13

TABLE E-1 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
HO	the number of health care officers necessary to support the weapon system	12
HOM	the health care O&M funds necessary to support the weapon system (FY79$K)	12
HT	the total cost of health care necessary to support the weapon system (FY79$K)	12
IRR	the intermediate reject ratio, i.e., the number of missiles failed by the MWS and forwarded to the depot for repair divided by the total number processed by the MWS	4, 6
LD	the labor required to successfully upload and download a missile (manhours)	1
LW	the launch weight of the missile (kilograms)	8.3
LWO	the launch weight . the missile less the ordnance weight (kilograms)	4, 6
M	the annual cost of modifications for an air-launched missile type (FY79$K)	15
MDSA	the annual MWS workload resulting from missiles stored afloat which reach their maintenance due date	4
MDSARR	the failure rate at the MWS of missiles which were returned to the MWS because the afloat storage maintenance due date had been reached	4
MDSS	the annual MWS workload resulting from missiles stored ashore which reach the maintenance due date	4

Variable	Definition	Cost Ele. Ref.
DBT	the total number of personnel, officers and enlisted, direct plus base operating required to operate and provide base support to the missile system	5, 11, 12, 13
DK	the total annual depot cost (FY79$K)	6
DL	number of equivalent direct enlisted required for handling and inspection tasks (Element 1)	1, 5
DKK	the depot unit cost of rework of a missile G&C section. (This does not include repair of G&C repairables.) (FY79$K)	6
DD	the number of equivalent direct officers required for handling and inspection tasks	1, 5
DK	the direct requirements of manpower and operating funds represented by the total cost of Elements 1, 3, 4 and 6 (FY79$K)	7
DKC	the total depot unit cost for a particular type missile (FY79$K)	6
EPR	the enlisted pay rate (FY79$K = 9.517)	1,3,5,11,12,13
ES	the annual cost of Engineering Support for a particular missile type (FY79$K)	8.2
FHY	the flying hours per year	3
FS	the annual cost of Fleet Support for a particular missile type (FY79$K)	8.1
HE	the number of health care enlisted necessary to support the weapon system	12
HI	the cost of handling and inspection of air-launched tactical missiles (FY79$K)	1

TABLE E-1 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
MISSRR	the failure rate at the NWS of missiles which were returned to the NWS because the afloat storage maintenance due date had been reached	4
MS	the maximum speed of the missile in free flight (mach)	6
MTBF	the mean-time-between-failure of the missile-dedicated equipment (hours)	3
MTTR	the mean-time-to-repair the missile-dedicated equipment (hours)	3
NA	the number of aircraft carrying the missile-dedicated equipment	3
NLF	the annual number of live firings	2
NM	the number of missiles carried per captive flight	1, 4
NMI	the annual number of modification kits to be installed	15
NMK	the annual number of modification kits to be procured	15
NPM_i	the number of Program Management personnel in the ith pay grade	8.4
NS	the annual number of missile sections to be transported	9
NT	the number of short tons to be handled by the RSSI department	10
NWS	the unit cost of NWS maintenance (FY79$K)	4
NWSM	the annual NWS workload; i.e., the number of missiles of a particular type which undergo NWS maintenance in a year	4,6,10
OMC	the annual cost of organizational/AIMD maintenance (FY79$K)	3
OME	the number of equivalent enlisted manyears required for organizational AIMD maintenance of missile system equipment	3,5
OPR	the officer pay rate (FY79$K = 22.141)	1,5,11,12,13
OT	the annual cost of operational training (FY79$K)	2
PE	the number of enlisted prisoners	13
PI	the percent of the inventory represented on a missile	8.1, 8.3
PCS	the annual cost (MPN funds) of PCS for weapon system direct and base operating personnel (FY79$K)	13
PM	the annual cost of Program Management (FY79$K)	8.4
QE	the annual cost of Program Management (FY79$K)	8.3
REE	the number of recruiting and examining enlisted necessary to support the weapon system	13
REO	the number of recruiting and examining officers necessary to support the weapon system	13
RFOM	recruiting and examining O&M funds (FY79$K)	13
RGSE	the annual cost of replenishment ground support equipment (FY79$K)	16
RSSI	the annual RSSI cost for a particular missile type (FY79$K)	10

TABLE E-1 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.	Variable	Definition	Cost Ele. Ref.
SDO	the annual cost of Supply Depot Operations required to support a weapon system (FY79$K)	7	WM	the containerized weight per missile (short tons)	10
SDT	the annual cost of Second Destination Transportation (FY79$K)	9			
SSR	the shore storage recertification time (maintenance due date – in years)	4			
TDP	the number of total direct personnel (officers and enlisted) involved in operating and supporting the missile system	5			
TE	the number of training enlisted required to support the weapon system	11			
TET	the number of enlisted personnel in transit	13			
TO	the number of training officers required to support the weapon system	11			
TOM	training O&M funds (FY79$K)	11			
TOT	the number of officers in transit	13			
TPA	the total cost of Personnel Support (FY79$K)	13			
TRT	total replacement training costs (FY79$K)	11			
TNMS	the total NMS maintenance cost (FY79$K)	4			
UCLF	the unit cost of a live firing including range costs, target simulation and post flight analysis support (FY79$K)	2			
WL	the depot workload; i.e., the number of G&C sections processed	6, 16			

TABLE E-2
LISTING OF VARIABLES BY SOURCE

1. <u>Program</u> Sponsor (Op-506)

Variable	Definition	Cost Ele. Ref.
ACMRT	the total annual time spent training on the Advanced Combat Maneuvering Range	2
CF	the annual number of captive flights	1
FHY	the flying hours per year	3
NA	the number of aircraft carrying the missile-dedicated equipment	3
NLF	the annual number of live firings	2

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

2. Program Office (PMA)

Variable	Definition	Cost Ele. Ref.
CAC_{1000}	the cumulative average hardware cost of the first one thousand missiles procured (FY79$K)	6, 16
CM	the cost of consumable material used in handling and inspection tasks (FY79$K)	1
CP_i	the annual cost of paying one Program Management person in the ith grade (FY79$K)	8.4
NM	the number of missiles carried per captive flight	1, 4
NMP_i	the number of Program Management personnel in the ith pay grade	8.4

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

3. Program Documents

Variable	Definitions	Cost Ele. Ref.
AAD	a dummy variable which takes the following values; 0, if the missile is an air-to-surface missile; 1, if the missile is an air-to-air missile	8.1, 8.3
AFRR	the failure rate at the NWS of missile which were returned to the NWS as observed failures in the fleet	4
ANSA	the average number of missiles stored afloat	4
ANSS	the average number of missiles stored ashore	9
ASR	the afloat storage recertification time (maintenance due date - in years)	4
ASW	the average section weight (thous. of kg.)	9
CFD	the average captive flight duration (hours)	4
CFFR	the captive flight failure rate (MTBF in hours)	4
LW	the launch weight of the missile (kilograms)	8.3
LWO	the launch weight of the missile less the ordnance weight (kilograms)	4
MDSARR	the failure rate at the NWS of missiles which were returned to the NWS because the afloat storage maintenance due date had been reached	4
MDSSRR	the failure rate at the NWS of missiles which were returned to the NWS because the shore storage maintenance due date had been reached	4
PI	the percent of the missile inventory comprised by the missile	8.1, 8.3

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

3. Program Documents (cont'd.)

Variable	Definition	Cost Ele. Ref.
MS	the maximum speed of the missile in free flight (mach)	6
MTBF	the mean-time-between-failure of the missile-dedicated equipment (hours)	3
MTTR	the mean-time-to-repair the missile-dedicated equipment (hours)	3
SSR	the shore storage recertification time (maintenance due date - in years)	4

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

4. Assistant Project Manager for Logistics (APML)

Variable	Definition	Cost Ele. Ref.
CI	the unit cost of installing a modification kit (FY79$K)	15
CMK	the unit cost of a modification kit (FY79$K)	15
CMA	the annual cost of consumable material for missile-dedicated aircraft equipment maintenance (FY79$K)	3
LU	the labor required to successfully upload and download a missile (manhours)	1
NMI	the annual number of modification kits to be installed	15
NMK	the annual number of modification kits to be procured	15
WM	the containerized weight per missile (short tons)	10

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

5. <u>Computed by Model</u>

<u>Variable</u>	<u>Definition</u>	<u>Cost. Ele. Ref.</u>
AF	the annual NWS workload resulting from missile failures, determined by BIT check and visual inspection	4
BE	the number of base operating enlisted personnel necessary to provide BOS services to missile system personnel	5
BO	the number of base operating officers necessary to provide BOS services to missile system personnel	5
BOM	the O&M funds required to provide BOS services to missile system personnel (FY79$K)	5
BOS	the total cost (O&MN and MPN) of base operating support (FY79$K)	5
DBE	the number of direct enlisted plus base operating enlisted (computed in Element 5) required to support the weapon system	5, 11, 13
DBO	the number of direct officers plus base operating officers required to support the weapon system	5, 11, 13
DBT	the total number of personnel, officers and enlisted, direct plus base operating required to operate and provide base support to the missile system	5, 11, 12, 13
DC	the total annual depot cost (FY79$K)	6
DE	the number of equivalent direct enlisted required for handling and inspection tasks (from Element 1)	1, 5
DGC	the depot unit cost of rework of a missile G&C section. (This does not include repair of G&C repairables.) (FY79$K)	6
DO	the number of equivalent direct officers required for handling and inspection tasks.	1, 5

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

5. Computed by Model (cont'd.)

Variable	Definition	Cost Ele. Ref.
DR	the direct requirements of manpower and operating funds represented by the total cost of Elements 1, 3, 4 and 6 (FY79$K)	7
DUC	the total depot unit cost for a particular type missile (FY79$K)	6
ES	the annual cost of Engineering Support for a particular missile type (FY79$K)	8.2
FS	the annual cost of Fleet Support for a particular missile type (FY79$K)	8.1
HE	the number of health care enlisted necessary to support the weapon system	12
HI	the cost of handling and inspection of air-launched tactical missiles (FY79$K)	1
HO	the number of health care officers necessary to support the weapon system	12
HOM	the health care O&M funds necessary to support the weapon system (FY79$K)	12
HT	the total cost of health care necessary to support the weapon system (FY79$K)	12
IRR	the intermediate reject ratio, i.e., the number of missiles failed by the NWS and forwarded to the depot for repair divided by the total number processed by the NWS	4, 6
M	the annual cost of Modifications for an air-launched missile type (FY79$K)	15
MDSA	the annual NWS workload resulting from missiles stored afloat which reach their maintenance due date	4
MDSS	the annual NWS workload resulting from missiles stored ashore which reach the maintenance due date	4

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

5. Computed by Model (cont'd.)

Variable	Definition	Cost Ele. Ref.
NS	the annual number of missile sections to be transported	10
NT	the number of short tons to be handled by the RSSI department	10
NWS	the unit cost of NWS maintenance (FY79$K)	4
NWSWL	the annual NWS workload; i.e., the number of missiles of a particular type which undergo NWS maintenance in a year	4, 6, 10
OMC	the annual cost of Organizational/AIMD Maintenance (FY79$K)	3
OME	the number of equivalent enlisted manyears required for Organizational/AIMD Maintenance of missile system equipment	3, 5
OT	the annual cost of Operational Training (FY79$K)	2
PE	the number of enlisted prisoners	13
PCS	the annual cost (MPN funds) of PCS for weapon system direct and base operating personnel (FY79$K)	13
PM	the annual cost of Program Management (FY79$K)	8.4
QE	the annual cost of Quality Evaluation (FY79$K)	8.3
REE	the number of recruiting and examining enlisted necessary to support the weapon system	13
REO	the number of recruiting and examining officers necessary to support the weapon system	13
REOM	recruiting and examining O&M funds (FY79$K)	13
RGSE	the annual cost of Replenishment Ground Support Equipment (FY79$K)	16
RSSI	the annual RSSI cost for a particular missile type (FY79$K)	10

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

5. Computed by Model (cont'd.)

Variable	Definition	Cost Ele. Ref.
SDO	the annual cost of Supply Depot Operations required to support a weapon system (FY79$K)	7
SDT	the annual cost of Second Destination Transportation (FY79$K)	9
TDP	the number of total direct personnel (officers and enlisted) involved in operating and supporting the missile system	5
TE	the number of training enlisted required to support the weapon system	11
TET	the number of enlisted personnel in transit	13
TO	the number of training officers required to support the weapon system	11
TOM	training O&M funds (FY79$K)	11
TOT	the number of officers in transit	13
TPA	the total cost of Personnel Support (FY79$K)	13
TRT	total Replacement Training costs (FY79$K)	11
TNWS	the total NWS maintenance cost (FY79$K)	4
UCLF	the unit cost of a live firing including range costs, target simulation and post flight analysis support (FY79$K)	2
WL	the depot workload; i.e., the number of G&C sections processed	6, 16

TABLE E-2 (cont'd.)

LISTING OF VARIABLES BY SOURCE

6. <u>Other</u>

<u>Variable</u>	<u>Definition</u>	<u>Cost Ele. Ref</u>.
EPR	the enlisted pay rate (FY79$K = 9.517)	1,3,5,11,12,13
OPR	the officer pay rate (FY79$K = 22.141)	1,5,11,12,13

TABLE E-3

NAVY AIR-LAUNCHED MISSILE OPERATING AND SUPPORT COST-ESTIMATING RELATIONSHIPS

(All Costs - FY79$K)

Cost Elements	Definitions	CER	Reference
o Operations			
1. Handling and Inspection	Organizational handling and inspection of missile and missile equipment	$HI = DE \times EPR + DO \times OPR + CM$ $DE = \frac{LU}{1440} \times NM \times CF$	Maintenance Engineering Analyses Deployment Reports
2. Operational Training	Pilot operational readiness training and live firings of missile	$OT = 0.80 \times ACMRT + NLF \times UCLF$	ACMR and live firings see Exhibit TFT-2
o Below-Depot Maintenance			
3. Organizational/AIMD Maint.	Maintenance of missile dedicated air-craft equipment at 061 levels	$OMC = OME \times EPR + CMA$ $OME = NA \times (FHT/MTBF) \times MTTR/1440$	Can be estimated with 3-M data
4. Intermediate Maintenance	Cost of personnel, consumable material and station overhead required for missile maintenance at Weapons Stations	$TNVS = NVS \times NVSWL$ $NVS = 0.312 + 2.5611IRR + 0.004LNO$ $NVSWL = AF + MDSA + MDSS$	Based on Budget Submission data, NAVAIR 4104 costs, and DCP failure rates
o Installations Support			
5. Base Operating Support	Personnel and material in direct support of missile handling and inspection pers.	$BO = 0.0014TDP; BE = 0.0178TDP;$ $BOM = 0.4946TDP; BOS = (BO \times OPR)$ $+ (BE \times EPR) + BOM$ $DBE = DE + OME + BE$ $DBO = DO + BO$ $DBT : DBE + DBO$	NARM Methodology, Proxy - number of personnel DBE, DBO, DBT used as proxy for succeeding Element 5
o Depot Maintenance			
6. Depot Maintenance	Manpower material and overhead costs needed for missile maintenance at Navy and contractor repair facilities	$DC = IWC \times WT.$ $IWC = 1.251 + 6.324HS + 0.013CAC_{1000}$ $WL = NNSWL \times IRR$	Based on data from NARF's NAVAIR cost factors, Budget Submission data
o Depot Supply & Technical Support			
7. Supply Depot Ops.	Costs of manpower and material needed for supply support of missile mainte-nance and operation	$SDO = 0.025DR$	NARM Methodology, Proxy - direct costs
8. Technical Support 8.1 Fleet Support	Cost of on-site technical personnel	$FS = 64.307 + 4.229PI + 113.530AAD$	Based on Budget Submission NAVAIR 4104 costs

TABLE E-3 (Cont'd.)

NAVY AIR-LAUNCHED MISSILE OPERATING AND SUPPORT COST-ESTIMATING RELATIONSHIPS
(All Costs – FY79$K)

Cost Elements	Definitions	CER	Reference
8.2 Engineering Support	Cost of maintenance and design engr.	$ES = 80.950 + 4.306FS$	Based on data from NAVAIR 410 and NAVAIR 510
8.3 Quality Evaluation	Cost of Naval Weapons Quality Program monitoring status & condition of air-launched weapon stockpile	$QE = 109.559 + 7.785 + 171.660AAD$	NAVAIR 4104
8.4 Program Management	O&S cost of missile-specific project	$PM = \Sigma MMP_1 \times CP_1$	Refer to PMA/PMS, See Section III-8.4
o Second Destination Transportation			
9. Transportation	Cost of commercial transportation of missiles from NWS's to depots & back	$SDT = NS \times ASW \times 0.1297$	Based on Budget Submission NAVAIR 412; see Sec.III-9
10. Receipt, Segregation, Storage, Issue	Cost of personnel and material for on-loadings and offloadings of equipment to & from storage depots & NWS's.	$RSSI = 0.29NT$ $MT = MWSWL \times WM$	NAVSEA 04J, See Table C-28 Appendix C
o Personnel Support Training			
11. Replacement Training	Variable cost of recruit and technical training	$TO = 0.0001DBE + 0.0028DBT + 0.0613DBO$ $TE = 0.1036DBE + 0.02332DBT + 0.0067DBO$ $TOM = 0.0041DBE + 0.3377DBT$ $TRT = (TO \times OPR) + (TE \times EPR) + TOM$	NARM Methodology, Proxy - Number of officer, enlisted ant total pers.
12. Health Care	Cost of medical support to personnel	$HO = 0.0092DBT,\ HE = 0.0182DBT$ $HOM = 0.4146DBT,\ HT = (HO \times OPR)$ $+ (HE \times EPR) + HOM$	NARM Methodology, Proxy - Number of personnel
13. Personnel Support	Cost of personnel programs	$PCS = 1.4515DBO + 0.4615DBE$ $REOM = 0.0889DBE,\ REO = 0.0009DBE$ $REE = 0.1036DBE,\ PE = 0.0119DBE$ $TOT = 0.0584DBT,\ TET = 0.0433DBE$ $TPA = REOM + (REO + TOT) \times OPR + (REE + PE + TET) \times EPR$	NARM Methodology, Proxy - Number of officers and enlisted
o Sustaining Investments			
14. Replenishment Spares	Cost of procuring missile spares and repair parts	$RS = 151.912 + 55.220PI$	NAVAIR 4123
15. Modifications	Cost of safety mods for missiles and equipment	$M = NMK \times CRK + NMI \times CI$	Based on Budget Submission O&MN - NAVAIR 4104, WPN-2
16. Replenishment Ground Support Equipment	Cost of replacing GSE	$RGSE = 0.0025 \times WL \times CAC_{1000}$	Refer to PMA/PMS, See Section III-8.4

TABLE E-4

SUMMARIZATION OF POINTS OF CONTACT

		Code	Person	Telephone
o	**Operations**			
	1. Handling and Inspection	NAVAIR 4104	Mr. I. Koniak	X-29773
	2. Operational Training	NAVAIR-06E	Mr. R. Crangle	X-27785
		NAVAIR-C6	Mr. H. Kollshegg	X-27675
		NAVSEA-06N	Mr. F. Belen	X-27748
o	**Below-Depot Maintenance**			
	3. Organizational/AIMD Maint.	NAVMAT 0415	Mr. Schanamann	X-28781
		NAVAIR 5205	Mr. F. Norton	X-27596
	4. Intermediate Maintenance	NAVAIR 4104	Mr. I. Koniak	X-29773
o	**Installations Support**			
	5. Base Operating Support	Op901 (NARM)	Ms. Ruth	X-55038
o	**Depot Maintenance**			
	6. Depot Maintenance	NAVAIR 4104	Mr. I. Koniak	X-29773
o	**Depot Supply and Technical Support**			
	7. Supply Depot Ops	Op901 (NARM)	Ms. Ruth	X-55038
	8. Technical Support			
	Fleet Support	NAVAIR 4104	Mr. I. Koniak	X-29773
	Engineering Support	NAVAIR 410	Mr. I. Koniak	X-29773
		NAVAIR 510	CAPT Glunt or	X-28571
			Mr. Cooper	X-28620
	Quality Evaluation	NAVAIR 4104	Mr. Sanders	X-29828
	Program Management	(see Sec.III, 8.4)		
o	**Second Destination Transportation**			
	9. Transportation	NAVAIR 412	Mr. Roberts	X-20091
	10. Receipt, Segregation, Storage & Issue	NAVSEA 04J	Mr. Warfield	X-21163
		NWSC Crane, Ind.	Mr. Wimmenauer	8-482-1358
o	**Personnel Support Training**			
	11. Replacement Training	Op901 (NARM)	Ms. Ruth	X-55038
	12. Health Care	Op901 (NARM)	Ms. Ruth	X-55038
	13. Personnel Support	Op901 (NARM)	Ms. Ruth	X-55038
o	**Sustaining Investments**			
	14. Replenishment Spares	NAVAIR 412	Ms. Savage	X-20239
	15. Modifications	PMA/PMS	(see table, Sec. III, 8.4)	
	16. Replenishment Ground Support Equipment	PMA/PMS	(see table, Sec. III, 8.4)	

GLOSSARY

ACMR	Advanced Combat Maneuvering Range
AFWTF	Atlantic Fleet Weapons Training Facility
AIMD	Aircraft Intermediate Maintenance Department
AO	Oiler
AOE	Fast Combat Support Ship
APML	Assistant Project Manager for Logistics
ASO	Aviation Support Office
AUR	All-Up-Round
BIT	Built-In-Test
BOS	Base Operating Support
CAIG	Cost Analysis Improvement Group
CER	Cost-Estimating Relationship
CES	Cost Element Struct...e
CVA	Attack Carrier
DCP	Decision Coordinating Paper
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
FLTAC	Fleet Analysis Center
FYDP	Five Year Defense Program
G&C	Guidance and Control
HARM	High Speed Anti-Radiation Missile
ICP	Inventory Control Point
ILS	Integrated Logistic Support
ILSP	Integrated Logistic Support Plan
MDCS	Maintenance Data Collection System
MDD	Maintenance Due Date
MEA	Maintenance Engineering Analysis
MMMU	Mobile Missile Maintenance Unit
MOAT	Missile-On-Aircraft-Test
MPN	Military Personnel, Navy
MSOD	Maintenance Support Office Department of Fleet Material Support Office

MTBF	Mean-Time-Between-Failure
MTTR	Mean-Time-To-Repair
NARF	Naval Air Rework Facility
NARM	Navy Resource Model
NAS	Naval Air Station
NAVAIR	Naval Air Systems Command
NOS	Naval Ordnance Station
NSN	National Stock Number
NWS	Naval Weapons Station
NWSC	Naval Weapons Support Center, Crane, Indiana
O&MN	Operations and Maintenance, Navy
OPNAV	Office of the Chief of Naval Operations
O&S	Operating and Support
OSD	Office of the Secretary of Defense
PCS	Permanent Change of Station
PMA	Program Management Air
PMA	Performance Monitoring System
PMTC	Pacific Missile Test Center
POM	Program Objectives Memorandum
R&D	Research and Development
RGSE	Replenishment Ground Support Equipment
RSSI	Receipt, Segregation, Storage and Issue
SPCC	Ships Parts Control Center
T/M/S	Type, Model, Series
WPN	Weapons Procurement, Navy
WQEC	Weapons Quality Evaluation Center
WUC	Work Unit Code
3-M	Maintenance and Material Management System